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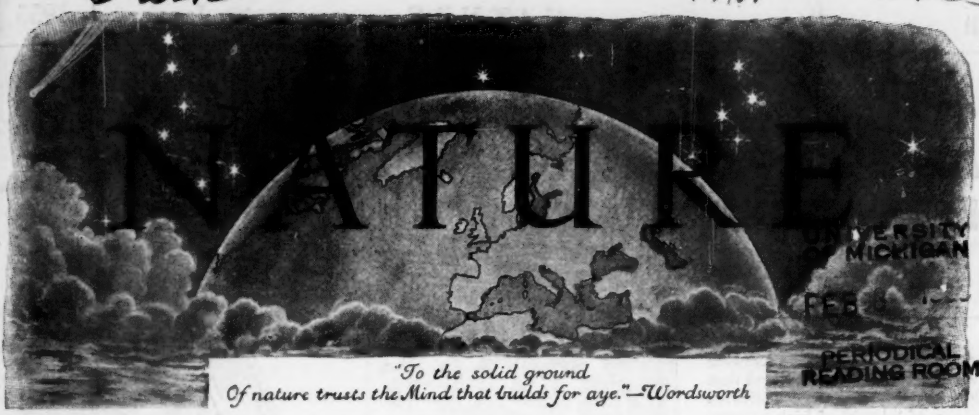

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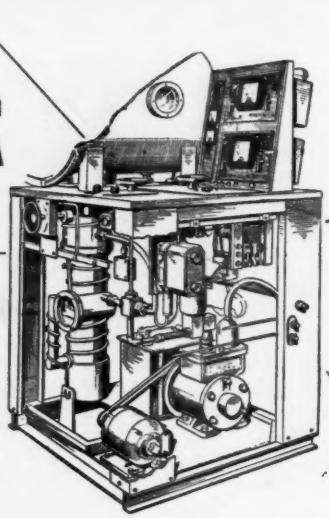

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NATURE

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ATOMIC ENERGY FOR PEACEFUL PURPOSES

LITTLE more than a year ago, on December 8, 1953, President Eisenhower first made his proposals for an international pool of atomic materials for peaceful purposes; and on September 25 the governments of the United States and of the Soviet Union disclosed the details of these proposals and of the unsuccessful efforts of the two countries to reach agreement on that plan. Progress has since been more marked than might have been expected, even although the published notes and memoranda exchanged between the two countries indicated the willingness of both countries to continue the negotiations. Agreement had then already been reached between the United States and six other nations to establish an international agency which would foster the growth and spread of the new atomic technology for peaceful purposes. Atomic materials were to be set aside for projects sponsored by the agency, and in due course the United States was to establish a reactor school to train representatives of friendly nations in the skills needed for their own atomic purposes.

At the end of September last, the United States delegate to the United Nations asked the steering committee to place on the agenda of the General Assembly as an important and urgent matter the United States proposals for the establishment of an international atomic energy agency for peaceful purposes. The Soviet Deputy Foreign Minister then suddenly announced his government's readiness to discuss the question in the General Assembly, though the discussions of the following two months have made it no clearer whether the U.S.S.R. is willing to participate in or support the international agency. Both Great Britain and the United States have given further weight to their proposals for promoting internationally the constructive use of atomic energy by their announcements that they are holding definite amounts of fissionable material for use in atomic research reactors abroad, and by their offer on November 5 to train foreign scientists as a first practical instalment of the Eisenhower plan for an 'atomic pool'. In this connexion Sir Pierson Dixon, the British delegate to the United Nations, stated specifically to the Political Committee of the Assembly that the British government could immediately offer a number of places in its four-week training course in the radioactive isotope school at the Atomic Energy Research Establishment at Harwell, and that other places might be made available at the Harwell School of Reactor Technology with courses lasting for periods of months.

It should be appreciated that, as Sir Winston Churchill told the House of Commons on November 16, Great Britain is at present the greatest exporter of radioactive isotopes in the world. Sir Pierson Dixon also told the Political Committee that it is Britain's intention to use the proposed agency to share our knowledge with other countries to the maximum extent permitted by security considerations and the demands for man-power and materials of our own projects. Moreover, the relaxation of restrictions on the exchange of information on atomic energy made possible by the Atomic Energy Act of 1954, both facilitates co-operation in the development of nuclear energy between the United States and other countries and further attests the sincerity of the American proposals to an extent which it is difficult for those outside the United States fully to appreciate.

In the course of the discussions at New York, the original American proposals were considerably modified. The draft resolution which the eight Western Powers specially interested in atomic energy sent to the Political Committee early in November noted the progress made in the negotiations between the eight Powers themselves—Great Britain, the United States, France, Canada, Australia, South Africa, Belgium and Portugal—for the establishment of an international agency, and recommended that they should continue. The resolution gave no lead, however, as to the functions, powers, organization, location, management, methods of voting or membership of the new body; and there was evidently no agreement among the sponsors themselves. Indeed, the United States Administration seems now to prefer bilateral arrangements with countries of its own choice for channelling technical knowledge and materials to the multilateral pool proposed by President Eisenhower. The international agency is thus left with functions little more than the preparation of bibliographies, the identification of scientific needs and resources, and the promotion of training facilities: in particular, this revised plan fails either to stimulate co-operation between East and West or to promote the use of nuclear experience and materials in the under-developed territories.

The resolution which was finally adopted unanimously by the Political Committee of the General Assembly on November 23, while not going into detail, referred specifically to the original objectives. It endorsed the negotiations now in progress, and expressed the hope that the international atomic agency will be established without delay; and that when the agency is established it will negotiate an appropriate form of agreement with the United Nations. The resolution recalls specifically, however, the initiative taken by the President of the United States on December 8, 1953, and international co-operation is recognized as important and urgent "in developing and expanding the peaceful uses of atomic energy to assist in lifting the burdens of hunger, poverty and disease". Moreover, the proposed international agency is "to facilitate the use by the entire world of atomic energy for peaceful purposes and to encourage international co-operation in the further development and practical application of atomic energy for the benefit of mankind".

The resolution also calls for an international technical conference of governments to be held under the auspices of the United Nations not later than August

1955, "to explore means of developing the peaceful uses of atomic energy through international co-operation and, in particular, to study the development of atomic power and to consider other technical areas such as biology, medicine, radiation protection and fundamental science—in which international co-operation might most effectively be accomplished". All members of the United Nations and the specialized agencies are to be invited to the proposed conference, and an advisory committee comprising representatives of Brazil, Canada, France, India, the Soviet Union, Great Britain and the United States was to be established to issue invitations to it, to prepare and circulate a detailed agenda, and to provide the staff and services required.

In organizing this conference, the Secretary-General of the United Nations, M. Hammarskjöld, has already engaged as his special consultant Dr. Gunnar Randers, head of the Kjeller Institute of Atomic Research in Norway and director of the joint Dutch–Norwegian atomic research project. The conference, which is expected to meet towards the end of August in Geneva, is likely to be a serious scientific congress, and its purpose will be not the exchange of views so much as to tackle the practical technical and economic problems involved, for example, in the generation of power from nuclear energy in various parts of the world, and particularly in under-developed areas. The advisory committee named in the Assembly's resolution is expected to meet this month.

All this represents a highly satisfactory outcome of the United Nations debate on atomic energy. The main Russian objections have been either met or withdrawn, and whether or not the U.S.S.R. participates, it has been well worth while that Britain and the United States should demonstrate their intention of going forward in collaboration with any nations willing to do so. It has shown the whole world that the major Western governments are prepared to lift some of their secrecy restrictions, and to take the initiative in helping others; and in particular it shows the industrially less advanced nations that they will not be denied the benefits of nuclear energy, however acute may be the limitations of their industrial and financial resources.

If, however, nuclear energy has thus been placed fairly in the context of industrial development and human welfare, in contrast to that of warfare and destruction, it is important that excessive expectations as to the rate of progress should not be aroused. When the international agency is ready to act as a clearing-house for information and assistance, its major task will be to ensure a clear public understanding of the limitations as well as the possibilities of nuclear power and the production and applications of fission products, including radiochemicals. Even in the United States, there is little chance of any important nuclear power production for another ten years, and it will then be a complementary source of energy rather than supplementing coal and oil in meeting the demand for electric power. Its principal effect in the United States is likely to be to prevent power costs rising because of higher fuel costs. In Great Britain it is hoped to have a nuclear reactor producing electricity commercially by 1958. It must therefore be made clear at the outset that, even for nations with the most advanced technical developments in this field, substantial contributions to industrial power from this source are unlikely within the next decade. Undue optimism in Africa or Asia, for example, might engender disappointment or suspicions which would hinder co-operation. This is one point at which scientists, both individually and collectively, through such bodies as the Atomic Scientists Association, and particularly the Science Co-operation Centres of the United Nations Educational, Scientific and Cultural Organization, may be able to assist. By turning discussion from questions such as the morality of atomic warfare to the constructive consideration and public understanding of the practical conditions for co-operation in the development of nuclear energy for peaceful purposes, or the application of fission products in medicine, agriculture and elsewhere, not only will the possibility of misunderstanding or frustration be minimized, but also the conditions promoted in which international agreement in relation to disarmament generally might be reached.

There is a further reason why the proposals for co-operation in the development of nuclear energy for peaceful purposes concern scientists in general. Any step which reduces the area of secrecy in regard to scientific and technical knowledge will be welcomed in principle by scientific men. The present proposal promises also to affect the costs of energy and the availability of raw materials as well as of fissionable material in various countries. The whole history of science shows that the exchange of scientific and technical knowledge is seldom in one direction for long. Britain may be at present the world's largest exporter of radiochemicals, but it is probable that before long she will be receiving from the European Agency for Nuclear Research at Geneva as well as contributing to it.

Before that stage can be reached, however, and especially in regard to the under-developed areas, there are certain conditions of scientific and technical development to be achieved; and it is important that these should be clearly understood. It is of little use, for example, for Britain to be able to supply radioisotopes to the hospitals of the Middle East, South-East Asia or Central Africa if the technicians are not on the spot to use such materials properly, or if the necessary equipment—which is expensive—is not available. Neither the technicians nor the equipment can be supplied without forethought. Staffs have to be found and trained, and if that training is given overseas, there is the question of cost.

Not all the territories which might benefit from such supplies and techniques can easily provide either the candidates for training or the finance to support and to equip suitably the institutions in which they will work when trained. Not all are yet ready to divert resources to such purposes, and still more does this apply to the production of nuclear power. The provision of the necessary technical

knowledge and trained technicians in under-developed areas, where nuclear power could contribute to industrial development and the raising of standards of living, will by itself do nothing to solve the economic and financial problems involved in the construction of the reactors and other plant required. Such problems will be encountered even if technical help is limited to those under-developed areas where nuclear energy promises to be the most economical source of power. Besides technical aid in the narrower sense, and probably—at least at the start—some overseas technical experts, such countries need the political maturity which can create the conditions likely to attract such experts, and also the substantial capital required to finance the developments and to set in train a well-balanced and intelligently applied economic programme. Much more is implied than a programme of scientific and technical co-operation, or of education in the scientific and technical sense.

Moreover, if the administration in under-developed countries is to be given a chance to raise its standards, too great care cannot be taken to avoid minor causes of misunderstanding and prejudice. Even in Great Britain, the Atomic Energy Authority has encountered difficulties, for example, in the disposal of wastes, through public ignorance and prejudice. In more backward countries, the consequences of mistakes arising through moving too fast and in advance, for example, of an adequate supply of those competent to handle radiochemicals safely, might well prejudice fatally the efforts of a local administration to establish the favourable conditions for economic development.

The British and the American governments have indeed given a welcome lead, and the direct and indirect possibilities of the proposals approved by the United Nations General Assembly cannot be over-stressed. If they are to be realized, much patient constructive effort will be required, and not least by scientists themselves. On them must rest no small share of responsibility for the success of the international scientific conference to be called next summer. Beyond that they could do something to promote the educational work which is required to promote a full public understanding of what is involved in co-operation in the development of nuclear energy, and the price that is demanded in self-discipline even in its utilization for peaceful purposes.

The repeated questions in the House of Commons as to the effect of atomic explosions on the weather testifies to the need for that educational work, even in the Western countries. That influence has been consistently denied by meteorologists; nevertheless it forms the subject of a short communication to the Paris Academy of Sciences (November 15) by C.-M. Martin. The danger of test explosions of nuclear weapons causing a permanent change in terrestrial radioactivity was admitted by Prof. A. Haddow in addressing the Parliamentary Association for World Government at a meeting in the House of Commons on December 8, and Prof. Haddow made two useful suggestions. First, he advocated an international meeting of scientists on an unofficial level, much on the lines which Prof. Lewis Mumford suggested last year to the American Philosophical Society, to discuss the implications of atomic warfare; and second, the founding of a permanent body forming a link between the political world and the United Nations and the world of science. The clear establishment of the facts and then making them widely known in some such way are at least safeguards against irrational prejudice suddenly forcing unilateral action which might endanger the public interest. There can indeed be few fields where the co-operation of men of science is more essential in promoting the public understanding upon which wise policy and effective international co-operation must be based than in that of nuclear energy, its development, its application and its control.

A CLASSICAL RESEARCH ON PLANT RESPIRATION

Analytic Studies in Plant Respiration

By the late F. F. Blackman. Pp. x+232. (Cambridge: At the University Press, 1954.) 40*s*. net.

UNDER the direction of the late F. F. Blackman some thirty-four years ago, the output of carbon dioxide by each of twenty-one Bramley's Seedling apples, in atmospheres of a variety of compositions, was followed over various periods of time. These atmospheres included normal air, pure nitrogen, pure oxygen and mixtures of oxygen and nitrogen in which the concentration of the former was less than in normal air. A feature of all the experiments was a transference of the apple under investigation from one atmosphere to another of different composition. The results of this research, in so far as it concerned apples which for part of the experimental period had been kept in an atmosphere of nitrogen, were afterwards published as three papers in the *Proceedings of the Royal Society* during 1928. It was in the third of these papers that Blackman, from his masterly analysis of the experimental data, put forward his theory of oxidative anabolism.

Although the experimental data dealing with carbon dioxide output in environments possessing low oxygen concentrations were touched on in that paper, and although the records of all the experiments were brought together as an appendix to the second paper, a detailed analysis of the experimental data was never published by Blackman. He had, nevertheless, spent much time and thought on the matter, and he had, indeed, prepared a series of papers in which the data were subjected to an analysis as exhaustive and masterly as that exhibited in the papers already published on carbon dioxide output in air and in nitrogen. The present volume contains these papers, six in number, previously unpublished, together with a reprint of the three published in 1928; it thus contains a complete account of the experiments of 1920–21 with Blackman's analysis of the data and the metabolic concepts he derived as a result of this.

In reading these papers, one cannot fail to be impressed by the amount Blackman was able to derive from the experimental data. It must be realized that, when the experimental work was undertaken, next to nothing was known of the effect of varying oxygen concentration on respiration; indeed, even

now our knowledge of this is very limited. From the data of carbon dioxide output alone, Blackman was able to separate the fermentation and respiration components of the total carbon dioxide output in low oxygen concentrations and to show convincingly that, as the fermentation component fell and the respiration component rose with increasing oxygen concentration, the carbon dioxide of respiration replacing that of fermentation bore a constant relation to the drop in fermentation up to the extinction point, that is, the lowest oxygen concentration in which fermentation fails entirely. His analysis further led Blackman to the conclusion that oxygen plays a threefold part in respiration. In addition to its oxidation function resulting in the production of carbon dioxide, and its anabolic function in oxidative anabolism, Blackman came to the conclusion that oxygen serves as an activator of the rate of conversion of inactive carbohydrate to the activated carbon compound which forms the starting-point of fermentation, and from which the substance forming the starting-point of respiration, if not identical with it, is derived.

In assessing the value of Blackman's work on respiration, it is necessary to bear in mind two things. One of these is the time at which the work was done. The papers now published for the first time are dated from 1935 to 1937, when views now current on the fermentation and respiration mechanisms were still only in an early stage of their formulation. The second point, and this is all-important, is that Blackman's approach to the problems of respiration was that of a physiologist and not that of the biochemist. He wrote (p. 127): ". . . we stress that our objective is to generalize the metabolism into classes of reactions and the biological control of their rates. This we take to be the proper objective of physiology as segregated from biochemistry which seeks to individualize the reactants and the products of intermediate metabolism". The reader of these papers can be in no doubt that in them Blackman's objective was achieved.

Thirty-four years is a long time in the history of modern plant physiology. It may well be asked why so long a period has elapsed between the winning of the experimental data and the publication of the full conclusions derived from them. The answer is no doubt to be found in Blackman's desire for perfection. It seems likely that he was still not satisfied with some, at any rate, of the papers now published for the first time. There are few of us who would not have been satisfied with very much less. Plant physiologists should be grateful that this record of work of the leading British plant physiologist of a century should have been made generally available.

Walter Stiles

GENETICS AND THE CHROMOSOMES

Animal Cytology and Evolution

By M. J. D. White. Second edition. Pp. xiv+454. (Cambridge: At the University Press, 1954.) 45*s*. net.

In all sexually-reproducing plants and animals the reproductive cycle depends on an alternation of two changes in the nucleus: an addition at fertilization, and a reduction at meiosis. Fertilization is simple, but meiosis is complicated. It consists, however, in a chain of events which almost universally shows a certain causal sequence, thus: (1) crossing-over is a condition of chiasma-formation; (2) chiasma-formation is a condition of metaphase pairing; (3) metaphase pairing is a condition of segregation and hence of reduction; (4) reduction is a condition of continuing sexual reproduction.

A most important object of the genetic study of chromosomes in recent years has naturally been to find out the meaning of these rules. It has appeared, for example, that the exceptions are confined to one sex, the heterozygous sex, in certain groups of dicecious animals. The rules always hold for the other sex. Hence, crossing-over is (at least) co-extensive with sexual reproduction, which is therefore invariably a mechanism of gene recombination within a group of organisms. Thus the cellular sequence of events crosses a population sequence of events and from this intersection arises a general chiasma theory, according to which a sexual species is a group of organisms enjoying gene recombination, while a chromosome is a group of genes capable of such recombination.

In the past twenty-five years the uniformity of plants has confirmed these principles, while the diversity of animals has directed attention to their exceptions, exceptions which illustrate the physiological control and evolution of the chromosome mechanism itself. For the development or limitation or re-interpretation of these ideas we naturally turn to an evolutionary account of the chromosomes in animals.

The first edition of this book by Dr. M. J. D. White was handicapped by the difficulty of separating animals from plants. The exceptions could not be related to the rules. Nevertheless, both were described and the fundamentals were correct. How does the second edition compare with it? The great fundamental is, of course, crossing-over. The treatment of this question may be taken as representative of Dr. White's methods and point of view.

It was Janssens who in 1924 made the first important chromosome contribution to the theory and based it on the study of grasshopper chromosomes. According to White (p. 83), Janssens assumed that "each chiasma is a place where two out of the four chromatids . . . have undergone crossing over". This is the current theory of crossing-over. But it was not Janssens's theory nor did White's first edition say so. Janssens assumed that at any chiasma 0, 2 or 4 chromatids might have crossed over earlier; and two of them might cross over later.

Janssens's theory was too complex and too permissive to be disproved. Not so his observations. Certain of them remain unsurpassed and undisproved. He described (*l.c.*, p. 178) and illustrated "l'absence de stade pachytène" in the grasshopper *Mecostethus grossus*. A restriction of pairing to one end of each chromosome led to a restriction of chiasma-formation and crossing-over to this end. This highly significant observation has since been confirmed by observations in plants and animals which underlie the current theory of meiosis. But White (p. 98) claims the support of Janssens for an exactly opposite account of the species: "there is direct observational evidence that pairing is complete at pachytene".

Assisted by this misreading of Janssens, White maintains a theory of the mechanism of crossing-over which he had advanced in his first edition. It is that "chiasma localisation is intimately connected with the alternation of heterochromatic and euchromatic

segments" (p. 98); or the distribution of euchromatin and heterochromatin is "largely responsible for determining the distribution of crossing over along the length of the chromosome" (p. 373). A little while before White advanced this view it had, however, been disproved by studies on plants carried out in order to test such an obvious possibility. For example, in *Fritillaria* there are species with and without heterochromatin: but both groups include species with localization and without localization of chiasmata. In *Paris* also there are species with and without heterochromatin: but both kinds have localization of chiasmata. In both genera all localization is near the centromere: but in *Fritillaria* the heterochromatin is near the centromere, in *Paris* it is away from the centromere. Nature apparently has in every circumstance misunderstood the theory.

Dr. White does not refer to the prior disproof of his views or to the relevant papers. He merely wipes out the whole field of inquiry. He points out that studies showing heterochromatin in plants by means of nucleic acid starvation are "suspect" and their description merely "picturesque terminology". On the other hand, studies showing the absence of heterochromatin in plants merely arise from "inadequate technique" and "insufficient evidence". The conclusions of those who have pursued this question are "untrue" (p. 373); and the critical citation is removed from this edition.

In general, Dr. White has attempted to cut out and throw away the theories he accepted in his first edition. But his treatment has been careless, and the result is inconsistent. The theory, an evolutionary theory, of pairing segments and differential segments in sex chromosomes was originally derived from the general chiasma theory. At one stage Dr. White accepts it (p. 285). But elsewhere he dismisses the interpretation on which it rests in *Drosophila* as "impossible" (p. 223) and in mammals as a "vue de l'esprit" (p. 286). Dr. White's application of this theory (which he illustrated as Fig. 84 in his first edition) was, I agree, impossible. But that was because he had copied it incorrectly from the original author. He has now cut it out.

Again, Dr. White rejects the view that parthenogenesis is an escape from sterility: "there is no reason to believe that it applies to animals at all" (p. 340). But three pages later he adopts the rejected view: parthenogenesis avoids the results of unsuccessful meiosis; "we consequently find that a number of species and races of parthenogenetic animals are polyploid . . ." (p. 343).

Dr. White too often omits to cite the publications he is contradicting and too often also he seems to have forgotten the evidence he is contradicting even when it appeared in his first edition. For example, when he asserts that the centromere can be broken and is not therefore "a special kind of gene" (p. 26), one supposes that he has forgotten that the theory of the centromere as a group of genes was derived from observations of its breakage. When he says that in a bivalent with a single chiasma "obviously the terms *reductional* and *equational*, as applied to the two meiotic divisions have lost all genetic meaning" (p. 232) one supposes that he has forgotten that this principle provides us with the means of mapping the chromosomes of the lower organisms. But when he states (p. 381) that "structural rearrangements" in chromosomes are of no importance in the origin of species and the hypothesis "is now seldom mentioned", can one suppose that he has forgotten all the evidence, old and new alike?

Above all, as Dr. White nearly stumbles on the principle of the evolution of genetic systems, one wonders whether he has noticed the idea that all chromosome behaviour is subject to physiological control which, being also genotypic, is subject to selection and adaptation. But, alas! These words are not in Dr. White's index. The problems behind them raise no difficulties for him. Their solution has made no impression on him. He writes, therefore, not of evolution as we now understand it, but of comparative anatomy. The difficulties with which we find him struggling are merely due to his being out of his depth when he writes about chromosomes and evolution.

C. D. DARLINGTON

CHEMICAL MICROSCOPY

Microscopy for Chemists

By Prof. Harold F. Schaeffer. Pp. viii + 264. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1953.) 34*s*. net.

ANY attempt to overcome the reluctance of the average chemist to take advantage of the many useful applications of the optical microscope in chemical practice deserves encouragement, and for that reason this introduction to chemical microscopy is to be welcomed. The author has dealt with most of the important aspects of the subject in a clear and concise manner, and while pointing out that it is best studied under the personal guidance of a competent instructor, he has endeavoured to present his material in such a way as to be intelligible to the worker who must depend on his own resources. Doubtless with the needs of such lone students especially in mind, he has given in the last ninety pages of the book a series of illustrative experiments with full explanatory notes and instructions. It is good to see that a description of the Kofler hot stage is included, though it is a pity that a little more space could not have been found in which to deal more fully with some uses of this valuable accessory which only receive bare mention, such as, for example, the elegant contact method for studying phase relationships in binary systems.

The least successful part of the book is the chapter dealing with polarized light. Admittedly the author states that an adequate treatment of optical crystallography lies beyond the scope of the book, but some parts of this section are quite misleading. Not only are there several errors of fact, but also the treatment fails to make clear that the optical properties of anisotropic crystals are directional in character, and that what is observed under the microscope depends on the particular optical section which a crystal presents and, in lesser degree, on its thickness. It is true that there is some mention of optic axes near the end of the chapter, but by the time the reader reaches this point, the damage will have been done. Extinction behaviour is discussed without any reference to the morphological properties of crystals (except by implication), and parallel extinction is incorrectly given as a property possessed solely by uniaxial crystals. The diagram on p. 111, which seems to be intended to show the changes in a typical biaxial interference figure on rotating the stage (though the type of figure is not specifically stated), is quite wrong. It gives a uniaxial cross and ring as the appearance of the figure in the extinction position,

while the isogyres are referred to as parabolas and are shown as moving in and out bodily, that is, not pivoting about the melatopes. Again, in distinguishing between uniaxial and biaxial crystals, the statements are made that a uniaxial crystal has two refractive indices and a biaxial crystal three, without making clear that these are the principal refractive indices and that they are not (with the exception of ω) necessarily presented by a random section, and that certainly no biaxial section presents three indices as the beginner might infer.

When dealing with that part of chemical microscopy which may perhaps be described as ordinary chemistry in miniature, the author is on firm ground, and the treatment is all that could be desired. So too is that in the introductory chapters on the principles, construction and use of the compound microscope and its accessories. The book is on the whole well produced, though consideration might be given in any future edition to improving the clarity of some of the photomicrographs of typical crystalline precipitates. Except for those parts criticized above, the book is a useful addition to the literature of chemical microscopy, particularly for the beginner.

N. H. Hartshorne

NATIONAL MUSEUM OF VICTORIA

Collections of a Century

The History of the First Hundred Years of the National Museum of Victoria. By R. T. M. Pescott. Pp. xii+186+18 plates. (Melbourne: National Museum of Victoria, 1954.) 30*s*. (Australian).

IT is proper that museums, in common with other traditional institutions, should pause at intervals and examine critically their past achievements, and from their failures or successes formulate their policies for the future in accordance with past experience. The present volume is a painstaking compilation by the director, Mr. R. T. M. Pescott, of the history of the first hundred years of the National Museum of Victoria. Dedicated to the memory of that great geologist, Frederick McCoy, the book forms a permanent record of the Museum. It also contains such pertinent remarks and observations that it has much of value for the whole museum profession and indeed for all those interested in museums. In an apt foreword, Sir Russell Grimwade, chairman of the trustees, stresses the especial responsibility of Australians to preserve a knowledge of the past in a country which, at any rate in its natural history aspects, has seen so many violent changes in the historical past.

In common with many museums, the National Museum of Victoria owes its origin to a local philosophical society and individually to an English army officer, Captain Andrew Clarke, R.E., who had the vision of a comprehensive museum in the colony of Victoria. Incidentally, it was he who gave it the right type of initial policy and insisted that its main function was to instruct rather than bewilder with a confused jumble of curiosities. In 1854 McCoy accepted the position of professor of natural science in the University of Melbourne and in 1858 was appointed director of the Museum. He remained in this position until his death in 1899. At the outset, he clearly differentiated between university museums, which exist for internal teaching purposes, and national museums, which contain material of national value for the instruction and recreation of the community. By means of wise purchases and other acquisitions McCoy amassed material, and the present comprehensive state of the natural history collections owes much to his foresight and vision. For example, the original description of the gorilla did not appear in print until 1847, when a skull only was included, yet by 1863 McCoy actually had specimens of these animals on display in his Museum. Of outstanding importance was the purchase in 1863 of the famous John Curtis collection of insects with many types, both British and foreign, offered, strangely enough, by Dr. J. E. Gray, of the British Museum.

In 1870 eighteen trustees were appointed to control the Museum, and McCoy had a particularly difficult time in obtaining funds. He complained of frustration in the execution of his plans, and it is to his credit and indomitable courage that he carried on with the Museum and eventually completed forty-three years of service, collecting some 510,000 specimens valued at more than £40,000.

After the death of McCoy, the Government of the State of Victoria turned naturally for advice on the future policy of the Museum to Prof. (later Sir) Baldwin Spencer, who had been appointed to the chair of biology in the University of Melbourne in 1887. He was appointed honorary director, and the Museum was moved from the precincts of the University to the Public Library buildings. The first result of the new policy was the inclusion of anthropology in addition to the sections of natural history, and secondly, the arrangement of the collections on an evolutionary rather than a geographical basis. Spencer resigned in 1928 in order to write up his earlier, and conduct new, researches, but in 1929 he died of a sudden heart attack.

James Kershaw, previously curator, was appointed director after the Museum had been served by two honorary directors (McCoy and Spencer) for a period of seventy-five years—surely a unique record. Kershaw brought to his new position a wealth of experience in the service of the institution. Since 1925 the Museum had unfortunately experienced a decline in public interest, and one of Kershaw's first acts was to introduce dioramas and habitat groups—the first to be seen in Australia. He also planned a special aboriginal art exhibition. In 1931 Kershaw severed his official connexion with the Museum—closing a record of more than seventy years continuous service of father and son—and Mr. D. J. Mahoney was appointed director. Mahoney placed an emphasis on the function of research in museums and immediately set about the reorganization of the *Memoirs of the National Museum*. He also advised the strengthening of the small staff by the appointment of honorary workers.

It was in 1944 that the present director was appointed, and during the ten years he has been in office it is evident that he has devoted much attention to the educational aspects of the Museum. He has already laid down how an educational objective could be achieved in a new building on a site which was reserved in 1948.

This well-produced volume closes with a chronological history of the institution and a list of the present trustees and staff. It is no dull monotonous historical record but a vivid—in some cases day-by-day—recital of the activities of a live institution. Moreover, it contains much that will serve as an inspiration to Mr. Pescott's museum colleagues throughout the world.

F. S. Wallis

History of the Primates

An Introduction to the Study of Fossil Man. By Prof. W. E. Le Gros Clark. Fourth edition. Pp. 6+119. (London: British Museum (Natural History), 1954.) 4*s*.

PROF. W. E. LE GROS CLARK is indeed a master in his subject, and the fourth edition of his "History of the Primates", printed for the trustees of the British Museum (Natural History), contains the latest ideas on this problem put in a way that the non-specialist can appreciate. Of recent years, much new evidence has accumulated. The discovery in Kenya of primitive apes of Miocene age (very possibly the basal 'stuff' from which has evolved both the line of man and of the anthropoid apes) and the finding by Prof. R. A. Dart and Dr. R. Broom in South Africa of the early Pleistocene Australopithecinae (ape-men not yet classed as human by the author, Prof. Le Gros Clark, until evidence turns up to show that they were talkers and tool makers) have completely revolutionized previous ideas on the subject.

The Piltdown hoax is treated firmly, if discreetly, and, of course, the Galley Hill skull is dismissed as being of a relatively recent date. He also dismisses as unproved the great antiquity of the Kanam and Kanjera finds in Kenya. The fact that new test methods have been discovered, which would make another such hoax as that of Piltdown impossible, is pointed out; these new methods, some chemical such as the fluorine test and others physical such as the carbon-14 method of dating, are extremely valuable aids for study quite apart from the question of detecting frauds.

Prof. Le Gros Clark concludes his book with a timely warning: "If Man has gained his intellectual dominance over his fellow creatures by concentrating his evolutionary energies on the development of his brain, it remains to be seen whether he can now maintain his position by contriving a method of living in orderly relations with members of his own species. If he fails to do so he may yet follow the example of many other groups of animals which have achieved a temporary ascendancy by an exaggerated development of some particular structural mechanism. He may become extinct". M. C. BURKITT

Bernstein Polynomials

By Prof. G. G. Lorentz. (Mathematical Expositions, No. 8.) Pp. x+130. (Toronto: University of Toronto Press; London: Oxford University Press, 1953.) 45*s*. net.

THIS book consists of four chapters. In the first, properties of Bernstein polynomials in the real domain are developed, beginning with the proof of the approximation theorem of Weierstrass. The close connexion with the theory of probability is emphasized, and some of the results, relating to monotone or convex functions or functions of bounded variation, are due to the author and have previously only appeared in the Russian journal *Mat. Sbornik*.

In the second chapter Bernstein polynomials are generalized and applied to the approximation of discontinuous functions of general type (integrable or measurable). The connexion with moment problems and the theory of summation is discussed, and the approximation of $f(x)$ by linear sums of powers x^{α_ν}, where $\alpha_0, \alpha_1, \ldots, \alpha_\nu, \ldots$ is a sequence such that $\Sigma\alpha_\nu^{-1}$ is divergent is studied. In Chapter 3 contact is made with abstract analysis. It begins with a discussion of Banach spaces and functionals, and then moment problems (with Stieltjes integrals) are considered. Other topics treated are rearrangements of functions, spaces of functions and Hausdorff methods of summation. The last chapter deals with the theory of Bernstein polynomials in the complex domain, and this ends with the consideration of degenerate polynomials and the connexion with the summation of power series.

The author has a clear style, even if a little concentrated in places, and has covered a great deal of material in the space available. The printing is excellent, as is usual with the University of Toronto Press. L. S. GODDARD

Molecular Structure and Related Problems

Edited by Y. Asami and Prof. K. Higasi. (Monograph Series of the Research Institute of Applied Electricity, No. 4 (1954).) Pp. vii+140. (Sapporo: Research Institute of Applied Electricity, Hokkaido University, 1954; Oxford: Basil Blackwell.) 25*s*.

PROFS. Y. ASAMI and K. Higasi have gathered together a group of nine papers, most of which represent work in molecular structure associated with their two departments at Hokkaido University in northern Japan. These articles, several of which are in the nature of reviews, were read at a symposium in Hokkaido in November 1953. They show how great is the development of theoretical and experimental chemistry in Japan.

As would be expected from a country where the tropolone system was first discovered, several of the articles deal with π-electron problems. But dipole moments, the hydrogen bond, the activated complex in chemical reactions, the dispersion of ultrasonic waves, paramagnetic resonance and intermolecular potentials are also included. The standard of publication and printing is high. The English language used is beyond reproach.

Mechanics of Materials

By Prof. E. P. Popov. (Prentice-Hall Civil Engineering and Engineering Mechanics Series.) Pp. xiv+441. (New York: Prentice-Hall, Inc., 1952; London: Macdonald and Co. (Publishers), Ltd., 1953.) 70*s*. net.

PROF. E. P. POPOV has added another to the list of excellent text-books which are available on elementary strength of materials. His object is to present the engineering undergraduate with a clear exposition of the fundamental principles of the subject. He does this admirably and has evidently put much thought into the order, as well as the nature, of the topics considered.

The sixteen chapters adequately cover most of the material that is usually presented in Britain under the title of 'strength of materials', as distinct from 'theory of structures'. This book differs from comparable works in certain respects. For example, it contains a treatment of torsion of thin-walled hollow members which is very welcome. Again, the method of virtual work is presented instead of Castigliano's theorem for the solution of problems by the energy method; certainly, much can be said for the virtual work approach.

The text contains plenty of examples, both worked and unworked (with answers). These problems are a main feature of the book and considerably increase its value. It is unfortunate that the price of the book is so high, because it may prevent many engineering undergraduates from possessing this excellent work.

SCIENTIFIC CENTENARIES IN 1955

By JOAN M. EYLES

It is a view generally held to-day, supported by vital statistics of the past two hundred years, that we tend to live longer than our forefathers. That being so, the ages of five men who were in their day distinguished scientists, and a sixth who is better known as a historian, all of whom died in 1555, seem worthy of special notice; for only one of them died before the age of sixty, while another reached seventy-seven, and the historian achieved the then remarkable age of eighty-five. One wonders whether a similar group of academic men of the present century could provide a better average. Yet it cannot be claimed that these men had any special advantage over their fellows. One was the son of a poor workman, another had a long struggle against adversity in his early years, and most of them travelled in Europe at a time when, although some of the epidemic diseases of the Middle Ages had nearly disappeared, the ravages of plague were particularly severe in Italy, France and Germany, and typhus fever, in one form or another, was frequently epidemic.

The historian was Polydore Vergil, an Italian born about 1470 in Urbino, who passed about fifty years of his life in England. He deserves attention here because he was the author of the first history of inventions, his "De Inventoribus Rerum" (About the Inventors of Things), a book which appeared first in 1499 and went into something like a hundred editions, in at least seven different languages. He also wrote a book on prodigies, in which he endeavoured to show that most of the prodigies he quoted could be explained on rational grounds, and those that could not be thus explained did not exist. Polydore arrived in England in 1502 as a sub-collector of Peter's Pence, and at the age of eighty he received permission to return to Italy, where he died on April 18, 1555[1]. His book of inventions continued to flourish and editions appeared even in the eighteenth century. He gathered his information from the Bible, the classics, and many medieval sources, and although his book is now no more than a curiosity, he can be regarded as one of the earliest to study the history of science.

Not many scientific authors of the sixteenth century have had one of their principal works printed twice in the past fifty years, but this is true of Georg Bauer (1494–1555), better known by the Latinized version of his surname, Agricola, whose beautifully illustrated work on mining and metallurgy "De Re Metallica" was translated by Herbert Hoover (later President of the United States) and his wife in 1912. The woodcuts have often been reproduced, and the Hoover translation was recently reprinted. Agricola was born at Glauchau in Saxony and after studying at the University of Leipzig for two years he took a post teaching Greek and Latin at Zwickau. His interests then seem to have turned towards medicine and science, and after further study, including two years in Italy, he obtained a medical degree, and in 1527 a post as doctor in the new mining town of Joachimsthal, in Bohemia. Here he began to make a close study of mining methods and in 1530 published his first mineralogical work, entitled "Bermannus", written in the form of a conversation between two learned physicians and a third man, Bermannus, versed in mining lore. Soon after, Agricola left Joachimsthal and in 1533 settled in Chemnitz, a Saxon town where he was resident until his death, and where, while following his profession, he continued to study mining and metallurgy. He died on November 21, 1555; but his "De Re Metallica" was not published until the following year, the delay being occasioned, it is said, by the preparation of the numerous woodcuts. It remained a standard work for nearly two centuries, and is to-day a source-book of outstanding importance.

An English physician who claimed friendship with Agricola was Edward Wotton, born in Oxford in 1492. He became a Fellow of Magdalen College, Oxford, in 1516 and in 1523 went to Italy for three years, studying medicine at Padua; it was probably during this period that he met Agricola. After Wotton's return to Britain he became a member of the College of Physicians and was its president during 1541–43. Later, he published a zoological work, "De Differentiis Animalium" (Paris, 1552) which, while largely a compilation from ancient authors, has been called the first systematic work in zoology. Wotton died in London on October 5, 1555.

Yet another medical man who died in 1555 was Jacques Dubois, also known by the Latinized version of his name, Jacobus Sylvius. Born at Amiens in 1478, the son of a poor workman, he eventually became one of the leading anatomists in Paris. He was a popular lecturer and attracted many students, including Vesalius and Servetus. Sylvius made many additions to anatomical nomenclature, but his merits are apt to be forgotten because Vesalius criticized his teaching. Nevertheless, it was Sylvius who invited the humble barber-surgeon Ambroise Paré to dinner and discussed the latter's novel treatment of gunshot wounds, an encounter which seems to have led to the publication of Paré's first book; for later Paré wrote: "Which things when I told him, the good old man requested me to publish in print my opinion concerning these things". Sylvius died on January 13, 1555, five years after he had been appointed professor of medicine in the Collège Royal.

The Collège Royal, later the Collège de France, was founded by Francis I in 1529, and began with two professors in Greek and Hebrew, but was rapidly extended to include chairs in medicine, mathematics and other subjects. The first holder of the chair of mathematics was Oronce Fine, who was appointed in 1531. Born at Briançon in 1494, Fine's early life was a long struggle against poverty. He taught mathematics in Paris, but was obliged to make and sell instruments to supplement his income, and he made a famous clock for John, Cardinal of Lorraine. In 1517 he went to prison, apparently for opposing, with other professors and students, the Concordat made by Francis I with Leo X. He was released in 1524. Fine was also a cartographer of note, and published a four-sheet map of France in 1538. He died in Paris on October 6, 1555.

Another cartographer and mathematician who died in the same year, although much younger at the time, was Regnier Gemma Frisius (1508–55), born at Dokkum in Friesland. When a medical student at Louvain he was a friend of Vesalius, whom he assisted to rob a gallows outside the town walls, in order to further their medical studies. Although

Gemma became professor of medicine at Louvain, and never left that University, his real interests lay in the realm of mathematics, and he gave private lectures in the subject, one of his pupils being Mercator. Gemma was the first to suggest the method of finding the longitude by the difference of times, although the unreliability of early portable clocks made it impossible to carry out the idea until John Harrison constructed a successful chronometer two centuries later. He was also the first to describe the method of elementary triangulation, illustrating his theory with an account of an actual survey, using Antwerp Cathedral as his first station. This account appeared as an appendix to Apian's "Cosmographia" in 1533[2]. Gemma died when only forty-six, on May 25, 1555, and in the year of his death revealed his advanced outlook by writing a letter in which he praised the new Copernican theory. He certainly deserves an important place in the history of cartography.

Yet another mathematical cartographer of the period was Giovanni Antonio Magini, born at Padua in 1555, a competent astronomer and a friend of Tycho Brahe. He produced a large map of Italy in 1608 and his atlas of Italy was published after his death by his son. In 1617 he died of apoplexy at Bologna, where he had held the chair of mathematics since 1588.

A surveyor of a somewhat different category was Richard Carew, of East Anthony in Cornwall, born on July 17, 1555, who published a "Survey of Cornwall" in 1602. Carew was a country gentleman and something of a poet, and was chosen when a lad of fourteen at Christchurch, Oxford, to debate extempore with Sir Philip Sidney, his elder by a year, before an audience of noblemen. He was a member of the first Society of Antiquaries, and his Survey is a very readable account of sixteenth-century Cornwall, with many interesting details concerning the tin mines and the fishing industry. Carew himself took great pleasure in a fishpond he had constructed and praised it in verse. ". . . My fishful pond is my delight". He died in 1620.

Two interesting tercentenaries are those of Pierre Gassendi and Domenico Guglielmini. Gassendi, born at Champtercier in Provence in 1592, was a child of poor parents, but rose to a high position in the Church. He revived the Epicurean philosophy and was an opponent of Descartes's philosophical views. In astronomy he was the first to observe a transit of Mercury (on November 7, 1631) which had been predicted by Kepler, and with Mersenne he carried out the first experiments on the velocity of sound. For a few years he was professor of mathematics at the Collège Royal, but his health obliged him to give up lecturing in 1647. He died in Paris on October 24, 1655.

Guglielmini, born at Bologna on September 27, 1655, at first devoted himself to astronomy, and in 1685 was appointed to the chair of mathematics at Bologna. In the following year he was given general supervision of the "waters of the State", in other words, of irrigation. This was an important task, and led to his publishing a valuable treatise on hydrostatics. The grateful Bolognese created a chair of hydrometry for him in 1694, and three years later he published a classic work on rivers, "Della Natura de'Fiumi". Guglielmini also made some important observations on the crystallization of chemical salts, work which has been evaluated recently by Prof. R. Hooykaas, of Amsterdam[3]. He was elected a Fellow of the Royal Society in 1697 and died in Padua in 1710.

Before passing on to the centenaries of 1755, we should perhaps direct attention to the death on January 17, 1705, of John Ray, a naturalist whose importance would certainly justify a two hundred and fiftieth anniversary commemoration.

The eighteenth century saw the beginning of an era of scientific expeditions, and one of the earliest of these was that organized by the Imperial Academy of Sciences at St. Petersburg, under the patronage of the Empress Anne, to explore Siberia. This was the "Great Expedition" of Vitus Bering, and the principal botanist was Johann Georg Gmelin (1709–55), one of the famous German family of that name, whose "Flora Sibirica" and "Reise durch Sibirien" are monumental records of an epic journey. Like many who went on this expedition, Gmelin died while still in his prime, on May 20, 1755. Another scientific writer and traveller of this period was the physician and botanist, Pierre Barrère (1690–1755), of Perpignan, who spent three years in Cayenne and published a detailed description of French Guiana.

An event which was to have considerable influence on the development of chemistry took place in June 1755. This was the reading by Joseph Black to the Edinburgh Philosophical Society of his classic paper published in 1756 as "Experiments upon Magnesia Alba, Quicklime and some other Alcaline Substances". It was not only his discovery of carbon dioxide, but also the quantitative manner in which his experiments were carried out, that make this the opening of a new era in chemistry. Another interesting event of the year was the founding by the Empress Elizabeth of the University of Moscow, the first Russian university.

Turning now to the bicentenaries of scientists born in 1755, we note first that of the French chemist, Antoine-François Fourcroy, born in Paris on June 15. He was not yet thirty when appointed professor of chemistry at the Jardin du Roi, where he succeeded Macquer. An eloquent lecturer, he did much to popularize the new nomenclature of chemistry based on the theory of Lavoisier. He was a zealous supporter of the Revolution, and in this respect his relations with Lavoisier were less happy. It has been suggested that by his conduct as a member of the Convention he contributed to the death of his irreplaceable colleague—an accusation that was refuted, one should add, by Cuvier. Fourcroy died in 1809, on the very day on which he had been created a count of the French empire by Napoleon.

Another Frenchman who belongs to this period is Nicholas-Jacques Conté (born 1755), a mechanical genius who came to the fore during the Revolution. Supplies of graphite from Borrowdale were interrupted by the war with Britain, and in 1795 he invented the process by which all lead pencils are now made, using powdered graphite and clay. In 1796, when experiments were being made with balloons for military purposes, he was placed in charge of all aerostatic establishments, and when Napoleon set out with the Egyptian expedition in 1798, Conté with his balloon corps accompanied him. In Egypt his inventive genius proved invaluable to the expedition, cut off from home supplies after Nelson's victory in the Battle of the Nile, and it is said he seemed able to invent immediately anything that was required. He died not long after his return to France, in 1803.

Two other Frenchmen born in 1755 are Jacques-Julien de Labillardière and F. D. de Reynaud, Comte de Montlosier. The former is the botanist whose valuable collections from a South Seas expedition fell into British hands as booty of war, but were released to the French government after representations had been made by Sir Joseph Banks, then president of the Royal Society. Montlosier, well known as a political writer, was also the author of a work on the volcanoes of the Auvergne, used by Von Buch and Sir Charles Lyell; in 1828 the latter spent "three delightful days" with the seventy-four year old Count at his château near Mont Dore. Montlosier died ten years later, in 1838.

Passing to Spain, an important bicentenary is that of Don Fausto de Elhuyar, born at Logroño on October 11, 1755. Don Fausto and his brother, Don Juan José, were skilled in metallurgy and mineralogy and are noted for having, in 1783, isolated metallic tungsten from its ore for the first time. Previously they had studied at Freyberg under the celebrated Werner and at Uppsala under Bergman. Don Fausto's expenses had been paid by the Sociedad Bascongada de Amigos del Pais (the Basque Society of Friends of their Country), and in 1782 he began to teach mineralogy at the Society's new college at Vergara (founded in 1777), where J. L. Proust was already professor of chemistry. In 1788 Don Fausto went to Mexico, having been appointed director general of mines by the King of Spain. There he founded the School of Mines, which was opened in 1792 and rapidly attained great prestige. He remained in Mexico for many years, but returned to Spain after the revolution and devoted himself to the mining industry of his native land. He died in Madrid, where the centenary of his death was impressively commemorated in 1933.

Another scientist of interest to geologists is the London physician, James Parkinson (1755–1824), who practised in London and was the first to describe a case of paralysis agitans, also known as 'Parkinson's disease'. Like many medical men, Parkinson was interested in geology, and he was one of the founders of the Geological Society. His "Organic Remains of a Former World" (1804–11), a general account of fossils, was for long a standard work; indeed, in 1833 it was reprinted, although its epistolary form made it somewhat long and cumbersome.

Another author of a monumental text-book was S. T. von Sömmerring (1755–1830), whose birthplace was also that of Copernicus, the Polish town of Thorn. His large treatise on anatomy was noteworthy both for its admirable illustrations and for the fact that its author had prepared editions in German and Latin at the same time. Von Sömmerring also has a place in the history of the electric telegraph, for in 1808 he designed an apparatus consisting of thirty-five glass tubes, each representing a letter or number, which could act as voltameters when connected with a voltaic pile, and so could be used for signalling messages, albeit somewhat slowly.

Other inventors of the same period were Aimé Argand (1755–1803), a Swiss physicist who designed the oil burner that took his name, and Oliver Evans (1755–1811), an American who initiated the use of relatively high-pressure steam in the United States about 1800.

In reviewing the centenaries of scientists who died in 1855, the outstanding one is certainly that of Karl Friedrich Gauss, the mathematical genius who died on February 23 of that year, aged seventy-seven. Born at Brunswick in 1777, the son of poor parents, his remarkable gifts brought him while still a schoolboy to the notice of Ferdinand, Duke of Brunswick, who himself deserves grateful remembrance for financing Gauss's subsequent education. The young man soon became renowned, first as a mathematician and then for his calculations in the field of astronomy. He was elected a foreign member of the Royal Society of London in 1804. After the death of his ducal patron, Gauss was appointed director of the Göttingen Observatory, and here he remained for the rest of his life. In the field of pure mathematics, Gauss has been ranked with Newton, and like Newton he was reluctant to publish his discoveries. Only his diary, fortunately preserved, reveals how many discoveries he anticipated. His seal, a tree bearing a few fruits, with the motto "Pauca sed matura", illustrates his attitude towards publication. He was more than fifty years old when he began his famous studies of terrestrial magnetism, and then, with his young colleague Wilhelm Weber, he founded the absolute system of measurement of electricity and magnetism. With Weber he designed the magnetometer, and in 1833 they constructed the first electromagnetic telegraph, which linked the Observatory and the Physics Laboratory at Göttingen. In 1838 he received the Copley Medal of the Royal Society for his researches. Gauss was a man of wide culture, and in the midst of all his scientific work maintained a lively interest in literature and languages. At the age of sixty-two he took up the intensive study of Russian, and within two years he had become fluent, corresponding wholly in Russian with scientific friends in St. Petersburg. Indeed, the title of 'Prince of Mathematicians' so frequently applied to him scarcely seems adequate for his wide attainments.

Two French scientists who died in 1855 were J. C. Sturm and F. Magendie. Sturm, who discovered the theorem named after him, was born in Geneva in 1803, and in 1826, with J. D. Colladon, he was the first to measure the velocity of sound in water, using a bell suspended in Lake Geneva. François Magendie, born at Bordeaux in 1783, achieved fame in a very different field. He was the creator of the experimental technique in physiology, and in his experiments upon animals acquired an unenviable reputation for ruthlessness. He is particularly noted for giving the first experimental proof of the motor and sensory functions of the spinal nerve roots, and is also remembered gratefully by physiologists for his early recognition of the genius of Claude Bernard, whom he made his assistant. Magendie died at Sannois near Paris on October 7, 1855.

Two well-known English geologists, who both died in April 1855, were Henry Thomas de la Beche, first director of the Geological Survey, and George Bellas Greenough, first president of the Geological Society. Greenough, the older of the two, was born in London in 1778. He was a leading figure in the establishment of the Geological Society in 1807, and steadfastly countered the opposition of Sir Joseph Banks, who, as president of the Royal Society, disliked the formation of a new and independent scientific society. Greenough devoted much time to assembling material for a geological map of England and Wales, which was published under the auspices of the Geological Society in 1820, replacing that of William Smith. In 1854 Greenough exhibited a large-scale geological map of India, and when he died on April 2 of the following year at the age of seventy-six, he was in Naples on his way to the east to make further

researches. His valuable library and maps were presented to the Geological Society, and many of his specimens are in the collections at University College, London.

Sir Henry de la Beche, born in London in 1796, died shortly after Greenough, on April 13. He had become a Fellow of the Geological Society in 1817, and of the Royal Society in 1819. He made many contributions to the geology of south-west England while still a young man, and in 1831 began to colour geologically the 1-in. Ordnance maps of that region. His own resources being insufficient, he obtained a grant of £300 from the Treasury to carry on this work, and in 1835 received an official appointment to continue the geological survey of Cornwall. This was the beginning of the present Geological Survey, and in the succeeding twenty years de la Beche fostered its growth until he was directing the work of a considerable band of skilled men, as well as supervising a Museum of Practical Geology and the attached School of Mines. He was honoured with a knighthood in 1842, and a few months before his death received the Wollaston Medal, the highest award of the Geological Society.

The month of April 1855 was also that of the death of Dr. Martin Barry (born 1802), who, after graduating as M.D. at Edinburgh in 1833, took up the study of embryology. In 1840 he was elected a Fellow of the Royal Society, from which he had received a Royal Medal the previous year. One of his most important observations was that of the penetration of the ovum by the spermatozoon in the rabbit.

Another Edinburgh graduate who was also a naturalist was George Johnston (born 1797), a founder of the Ray Society and for many years one of the editors of the journal now known as the *Annals and Magazine of Natural History*. Johnston was a resident of Berwick-on-Tweed, where he was thrice mayor, and died there on July 20, 1855. A namesake who died a few weeks later was James Finlay Weir Johnston, a Scottish chemist, who after studying under Berzelius became the first reader in chemistry and mineralogy in the University of Durham, a position which he held until his death. He was also chemist to the short-lived Agricultural Chemical Association of Scotland, and the author of a "Catechism of Agricultural Chemistry and Geology", which went into thirty-three editions in five years and was translated into nearly every European language.

Two other interesting centenaries are those of the chemist C. B. Mansfield (1819–55), and the civil engineer and inventor Bryan Donkin (1788–1855). Mansfield is noted for having found a method of extracting benzene from coal-tar, a discovery which laid the foundations of the aniline industry. Donkin, in addition to many inventions in the paper-making industry, in 1812 began in Bermondsey the commercial preservation of meat and vegetables in air-tight tins, a process that was welcomed by seafarers and explorers long before it revolutionized the domestic kitchen.

The list of those born in 1855 is noteworthy for including three past presidents of the British Association for the Advancement of Science. Sir David Bruce, one of the great pioneers of medical research, was president at the Toronto meeting in 1924. Born in Melbourne, Australia, on May 29, 1855, he studied medicine at Edinburgh and then entered the Army Medical Service in 1883. While serving in Malta he investigated the disabling Malta fever (of much wider distribution than its name implies), and in 1886 discovered the micro-organism that caused the disease, although seventeen years elapsed before goat's milk was recognized as its carrier. Next, working in Africa, Bruce discovered the trypanosome that is the cause of the fly disease in cattle and horses, and later, with others, was able to prove the connexion between the tsetse fly, Gambia fever and sleeping sickness. Bruce received many honours for his brilliant researches. He died in 1931, only surviving by a few days his wife, who had constantly assisted him in all his work.

In the year following Bruce's death, 1932, the president of the British Association was Sir Alfred Ewing, born at Dundee on March 27, 1855. He had been professor of engineering in Tokyo during 1878–83, during which period he began the researches in magnetism for which he received a Royal Medal in 1895. Professor at Cambridge during 1890–1903, where he is regarded as the virtual founder of the engineering school, he resigned to take up an appointment as Director of Naval Education, and then devoted his energies to the re-organization of scientific training in the Royal Navy. To the general public he is best known for his work during the First World War in 'Room 40', where the de-coding of secret wireless messages was carried on. This work was followed by a long period of office as principal of the University of Edinburgh, during which the new science blocks known as King's Buildings that are a permanent memorial to his administration were erected. In 1929 he retired to Cambridge, where he died six years later.

Frederick Orpen Bower, the Yorkshire botanist who died as recently as 1948, was president of the British Association when it met in Bristol in 1930. Bower was noted both as a morphologist and for his work on the origin of the land flora, which he discussed in several books, the latest being "Primitive Land Plants" (1935). Born at Ripon on November 4, 1855, and educated at Repton and at Trinity College, Cambridge, he reversed the more usual drift south and was regius professor of botany at Glasgow for forty years. He received the Darwin Medal of the Royal Society in 1938.

A British physicist who was also an extremely practical experimentalist was Sir Charles Vernon Boys, born at Wing, in Rutland, on March 15, 1855. By his choice of quartz fibres for torsional suspensions he made an important step forward in technique. Boys procured fibres of the requisite fineness by the ingenious method of shooting from a cross-bow an arrow attached to a heated quartz rod, and later he used these fibres in the apparatus that he designed for his classic determination of the constant of gravitation. This apparatus is now in the Science Museum at South Kensington. Boys, who received from the Royal Society a Royal Medal in 1896 and the Rumford Medal in 1924, died in 1944.

Two others who will be remembered this year for discoveries that became of great industrial importance are C. F. Cross (1855–1935), who in obtaining viscose from cellulose in 1892 laid the foundations of the artificial silk industry, and William Friese-Greene (1855–1921), the Bristol inventor whose patent for a camera and projector, filed in June 1889, is held to support his priority over Edison in the field of cinematography.

An eminent French meteorologist, L. P. Teisserenc de Bort, was born in Paris on November 5, 1855, and died at Cannes in 1913. He was a pioneer in the

investigation of the upper air, using balloons carrying self-recording instruments. He showed there were two divisions of the atmosphere, and named the upper isothermal layer the stratosphere.

Other noteworthy centenaries are those of Bohuslav Brauner (1855–1935), the Czech chemist who after studying under Roscoe at Manchester carried out important researches on the chemistry of tellurium and the rare earths; H. F. Geitel (1855–1923), who collaborated with Elster in work on the photoelectric cell; and Christian Bohr (1855–1911), a Danish physiologist who made important studies in the physiology of respiration. There is also Percival Lowell, born at Boston on March 13, 1855, who established the Flagstaff Observatory in Arizona. Here he carried out detailed studies of Mars, as well as a number of spectroscopic studies of planets, comets and spiral nebulæ, work which remains of permanent value, even if his frequently expressed belief in the existence of life on Mars has failed to find general support.

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WHAT IS A VIRUS?*

By Dr. KENNETH M. SMITH, F.R.S.

Plant Virus Research Unit (Agricultural Research Council), Molteno Institute, Cambridge

THERE are two main theories on the nature of viruses; one supposes that they are parasitic organisms which have developed parasitism to the highest possible degree. Laidlaw has suggested that parasites, through the indolence of living a 'borrowed life', gradually give up making substances essential for their growth because they are always at hand in the cells of the host. The other theory suggests that some viruses at all events are not of external origin at all, but are derived from the cell proteins of one organism and only become viruses when transferred to the cells of another different organism. I have not attempted to answer the question which supplies the title to this discourse, but leave it to the reader to choose for himself between the alternative answers to the question "What is a Virus?".

Only the viruses affecting plants and insects are dealt with, since these have been my special study.

Plant Viruses

The earliest known record of a plant virus disease, although of course it was not recognized at that time as such, is to be found in a description published in 1576 of a variegation in the flower colour of tulips. This is now known to be a virus of the mosaic type. Change in the colour of the flowers, or 'breaking' as it is called, is a fairly common symptom of plant virus diseases. Besides the tulip, the blood-red wallflower frequently shows a yellow flecking of the petals, and this bodes ill for the grower of cabbages and cauliflowers in the district since the virus which affects the colour of the wallflower causes a severe disease in cruciferous crops.

The symptoms caused by viruses in plants take a great variety of forms; besides the simple mosaic pattern on the leaves, there are other leaf changes. There may be numerous concentric rings with a central spot, or leaf distortions of various kinds. Sometimes the leaf blade is entirely suppressed, leaving only a string-like tendril, or again there may be outgrowths of secondary leaves from the under-surface of the leaf blade; these are known as enations. Frequently the whole plant is distorted or dwarfed, with many short stems; this type of disease is known as a witch's broom. In one interesting virus disease which affects leguminous plants, the chief symptom is the production of tumours which seem analogous to the various virus tumours produced in animals.

Viruses attack all kinds of flowering plants, including forest trees. In Great Britain the most important virus diseases are those attacking the potato, the sugar beet, raspberries, strawberries and the brassica crops. In North America the virus diseases of stone fruit trees, peaches, plums and cherries, are becoming a very serious problem, and there are signs that the same problem will have to be faced in Britain also in the near future.

In addition to some of the main symptoms of virus-diseased plants, one rather interesting internal change should be described. In the cells of plants infected with some viruses, particularly that of the tobacco mosaic disease, there can be seen by the aid of the ordinary microscope a rather curious body with a superficial resemblance to an organism. Indeed, when these bodies—*X*-bodies they are called—were first observed, they were described by some workers as the causal organism of the disease. These *X*-bodies are of two kinds, amorphous and crystalline, and it has been shown recently that the crystalline inclusions are actually aggregates of the virus itself. This has been done by picking out the crystal from the cell, dissolving it in a micro-drop of water and photographing it on the electron microscope (Williams and Steere[1]).

One property of plant viruses which distinguishes them from most bacterial and fungal plant pathogens is their close relationship with insects. Many viruses depend entirely upon insects for their transfer from diseased to healthy plants. The insects which carry plant viruses—termed vectors—are mostly, but not all, of one kind; they belong to the order Hemiptera and are of the sap-sucking, not leaf-eating, type. The commonest insect of this kind, of course, is the aphid, and many viruses are transmitted from plant to plant by these insects.

There is another kind of sap-sucking insect belonging to the same order as the aphids and known as a leaf-hopper. These insects are concerned, particularly in North America, with the spread of a number of important plant viruses. In certain of these cases it has been proved that the plant virus actually multiplies inside the insect. This is very interesting, because a plant virus which multiplies inside an animal must have some affinities with the animal viruses. It has been shown by Black[2], working in America, that a virus affecting clover is transmitted from the parent insect to its offspring. He also found that the virus could be carried on for a period of four years covering fifteen generations without the insects having access to a further source of virus. This shows, fairly conclusively, that the virus must have been multiplying inside the insects during that time, otherwise it would have involved a dilution of 10^{-17}, which is far greater than any virus could stand.

Before concluding this brief account of the relationship of plant viruses with insects, mention must be made of an interesting virus, only recently

* Substance of a Friday Evening Discourse delivered at the Royal Institution on November 12.

discovered, causing the disease known as turnip yellow mosaic. This virus, curiously enough, cannot be transmitted by aphids or any other sucking insect. The vector in Nature is the common flea beetle; but in experimental studies it has been found to be transmitted by any biting insect without salivary glands. The explanation lies not so much in the absence of the salivary glands as in the fact that insects such as beetles, which lack these glands, regurgitate while feeding. In so doing, the virus which has been swallowed and which remains in the fore part of the gut for a week or more is brought into contact with the healthy leaf in the process of eating, and the new plant thus becomes infected. Thus it comes about that any biting insect which regurgitates while feeding can transmit the virus. It has been proved experimentally that such insects as grasshoppers and earwigs, which fulfil these conditions, can also transmit the turnip yellow mosaic virus.

One of the most interesting relationships between some viruses and their hosts is that of latency. Broadly speaking, this means that a virus may be present in an organism without causing a disease. A familiar example of latency is herpes simplex or 'cold sore' in man. The herpes virus remains symptomless unless stimulated by some external factors to multiply and become virulent. These external stimuli differ greatly and vary from emotional disturbances, exposure to ultra-violet light (sunlight) or the advent of another virus, for example, that of the common cold. A truly latent virus, however, never produces a disease in its host and cannot apparently be made to do so. There are two good examples of this type of latency among the plant viruses. One is invariably present in a well-known potato variety, King Edward, and no plant of that variety has ever been found free of the virus. The other occurs at certain periods of the year in a very high percentage of the commercial sugar beets, not only in Britain but so far away as Southern California. It is not possible to detect the presence of either of these viruses in their hosts except by transfer of the sap to other plants, which then do show symptoms of virus infection. The most interesting fact about these two viruses is that apparently they have no natural means of spread; and yet the latent sugar beet virus occurs in a very large number of plants without it being, so far as we know, either seed- or insect-borne. It may be, of course, that there exists a method of spread of which we know nothing; but in the meantime these two viruses lend support to the idea that some plant viruses may be normal cell constituents in one species and become a virus when transferred to another plant.

Certain plant viruses occur in such high concentration in the plant that it is possible to extract them by means of chemical precipitation methods and purify them to such an extent that they crystallize. Many plant viruses, however, because of instability or low concentration in the host, cannot be isolated in sufficient quantities; but about half a dozen have now been crystallized and the crystals may be eight- or twelve-sided, or take the form of flat plates.

It has been mentioned earlier that we now know quite a lot about the size and shape of viruses; but this could not be achieved by means of the ordinary microscope. With the electron microscope, however, it is possible to obtain a resolving power of 5 mμ, and the latest instrument is said to give a resolution of 1 mμ (10 A.). This, of course, is far smaller than any known virus, and we can now see and photograph any virus which can be obtained in a suitably pure condition. The first virus to be photographed on the electron microscope was that of tobacco mosaic—appropriately enough, since it was the first virus to be discovered. The photographs confirmed a previous belief that the particles are long rods and showed that they measure about 300 mμ in length by about 15 mμ in width. Several other plant viruses have been photographed and some of them are spherical or near spherical, whereas others are rods.

It is hoped, however, to do more with the electron microscope than observe the size and shape of viruses. It is possible now, by means of the technique of cutting ultra-thin sections of fixed material, to observe the virus inside the cells of the host.

Very little is known as to how viruses multiply, and the examination of sections of infected cells at different stages of the disease may help to solve the problem. In looking for viruses in sections of infected cells, it helps matters if the virus in question is of a characteristic shape. For example, it is easier to see the long rods of tobacco mosaic virus inside the cell than it is to find some of the very small spherical viruses. Sections of cells infected with tobacco mosaic virus show the virus particles in and around the chloroplasts.

Insect Viruses

The viruses which attack insects are for some reason the least investigated of all the virus groups. We know that there are several quite different kinds of viruses, but the majority have this in common that they attack the larval stages rather than the adults. The best known are the 'polyhedral diseases', so called because of the presence in the tissues of infected larvæ of huge numbers of polyhedral, or many-sided, crystals. These crystals have been recognized for many years and much controversy has raged about them. However, it is now known that they are not the virus itself, but the virus is contained within them. This is a point of difference from the plant virus crystals, which are actually composed only of virus particles.

It has recently been shown in our laboratory at Cambridge that there exist two entirely different and distinct types of polyhedral diseases. There is first the classical nuclear type, in which the virus starts to multiply and the polyhedra to form, inside the nuclei of cells in the tracheæ, blood and skin of the diseased caterpillar. It was shown not many years ago by Bergold[3], with the electron microscope, that if the crystals are treated with weak sodium carbonate they dissolve, leaving behind a thin membrane containing numerous rod-shaped virus particles.

In the second type of polyhedral disease, only recently discovered (Smith and Xeros[4]), the virus multiplies and the polyhedra form in the cytoplasm and not in the cell nucleus. Moreover, the polyhedra are confined to the gut of the diseased caterpillar. When this type of crystal is treated with weak sodium carbonate and photographed on the electron microscope, the result is somewhat different. The crystal only partially dissolves, leaving a honeycomb-like skeleton, and there is no residual membrane. Further work has shown that the virus particles are spherical and not rod-like, and each round virus particle fits into one of the round holes in the polyhedral crystal. We thus have the interesting phenomenon in which the shape of the virus particle is correlated with a particular type of crystal, site of

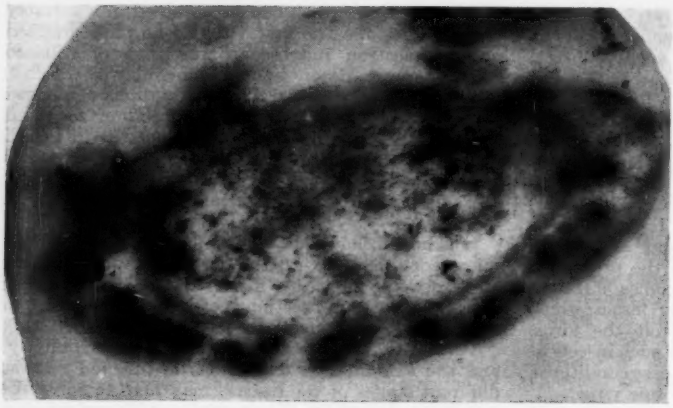

Fig. 1. Thin section through a diseased blood cell of the leatherjacket (*Tipula paludosa*) showing the greatly enlarged nucleus filled with virus rods. The largest of the bodies seen between the nuclear membrane and the edge of the cell is a polyhedral crystal. × 1,000

multiplication and particular set of symptoms. A further interesting fact is that each of these virus particles is composite, consisting of four or five extremely minute spheres (Smith and Xeros[5]).

While the majority of polyhedral diseases attack the larvæ of Lepidoptera, butterflies and moths, there is one interesting virus of this type which affects the larva of the cranefly or daddy-long-legs (Diptera). This fly larva, known as a 'leatherjacket' because of its tough integument, is an agricultural pest of some importance.

The virus causes a blood disease, a kind of leukæmia, and the number of blood cells is enormously increased and pack the blood cavities. Towards the end of the disease the polyhedral, or rather crescent-shaped, crystals form at one end of the enlarged pathological blood cells (Fig. 1). These crystals have very extraordinary properties and behave quite differently from the polyhedral crystals of the Lepidoptera. When put into alkali, they become transformed into long thin threads or worm-like shapes; but when returned to water they resume their crystalline appearance. Thin sections of these remarkable crystals reveal the presence inside them of many virus rods.

Another type of virus disease infecting caterpillars is known as a 'granulosis' or 'capsular disease'. Here the place of the polyhedral crystal is taken by numbers of very small granules, each of which contains one or sometimes two virus rods instead of hundreds as in the polyhedra. A disease of this type attacks a caterpillar which is a pest of the tea bushes in Ceylon, known as the 'nettle-grub'. When the granules of this disease are treated with weak alkali, the outer capsule dissolves leaving only a thin 'ghost', and inside this is a second capsule containing the virus rod. The reasons for this curious 'Chinese box' arrangement are not known.

A very interesting virus infecting the leatherjacket, in addition to the polyhedral virus already mentioned, has recently been discovered in our laboratory and was later briefly described by Xeros[6]. This virus, the particles of which tend to have a hexagonal shape, occurs in very high concentration in the insect, and when a drop of fluid is extracted from a diseased larva the particles arrange themselves in the regular manner shown in Fig. 2.

Thin sections of the fat body of an infected larva show such enormous numbers of virus particles that the whole material of the organ seems to be converted into virus. The arrangement of the virus particles inside the fat body is very interesting; in addition to the large numbers of isolated particles, there occur numerous masses or agglomerations of virus particles which look superficially like some of the intracellular inclusions of other insect viruses. These masses, however, appear to be composed only of virus particles (Fig. 4).

In thin sections of the virus particles themselves (Fig. 3) a darker area or 'nucleus' is visible, suggesting that they may have a composite nature similar to that of the cytoplasmic polyhedral virus previously described.

At the present time we know very little of the way in which viruses multiply, and it is hoped to learn more of this process by the examination of thin sections of cells under the electron microscope. The nuclear polyhedral diseases of insects, to which we have already referred, are very suitable for this kind of study. Because the main initial focus of virus multiplication is in the cell nucleus, it is possible to make an intensive study of this circumscribed area. From an investigation made at Cambridge on the nuclear disease of the silkworm, the following sequence of events has been built up (Smith and Xeros[7]). First, the infected nucleus enlarges greatly until it practically fills the cell. Then the chromatic net or central mass begins to form, and from the edges of this, and of the chromatin lining the nucleus, the virus rods begin to appear, very much as if they were being pushed out from within. At this stage there are no free virus rods in the 'ring zone' of the nucleus.

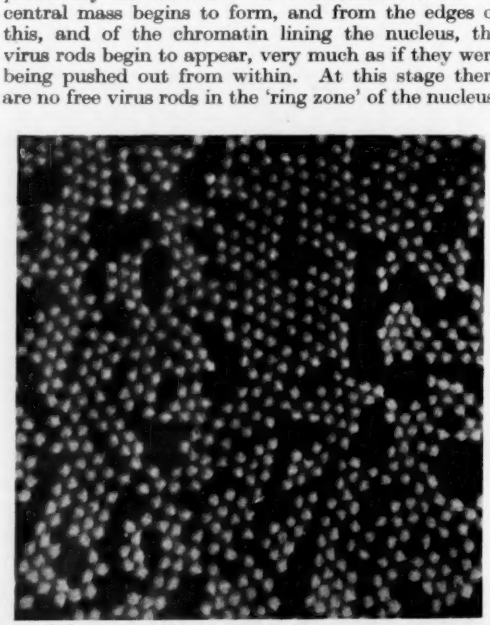

Fig. 2. A drop of fluid from a leatherjacket infected with a new virus disease; note the large numbers of virus particles and their regular arrangement. × 10,000

It is interesting to note that as the virus rods are apparently extruded, they seem to be longer than the normal rods and can be seen dividing. In the next stage many free virus rods appear, and it should be noticed that they are without the enveloping capsule which surrounds each virus rod when inside the polyhedral body. When the interior of the nucleus contains many virus rods, the protein of which the polyhedral crystals are made begins to form. It is, in fact, actually possible to see the virus rods being incorporated into the crystals as it forms around them. In the last stage the nucleus becomes filled with the polyhedral crystals, in which are incorporated the virus rods, and there are no free virus particles visible in the nucleus. At this stage the nuclear membrane bursts and the polyhedral crystals are liberated.

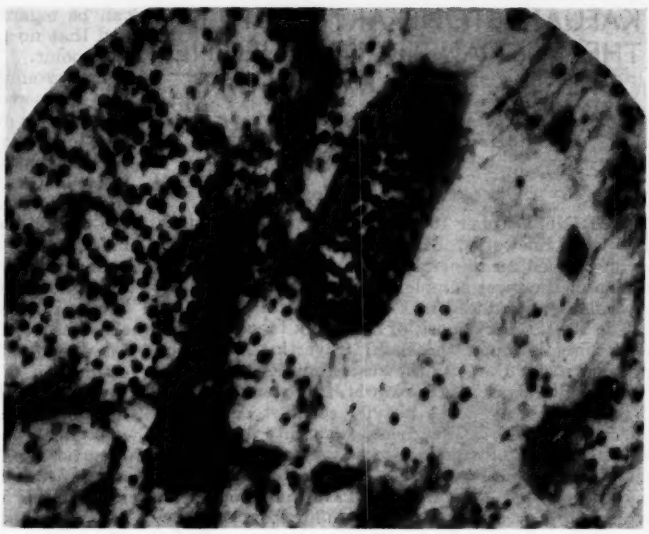

Fig. 4. Section through part of the fat-body of an infected leatherjacket; note one of the many aggregates of virus particles. × 16,000

Electron micrographs by S. Vernon-Smith

Much the same kind of process seems to take place in the diseased blood cells of the leatherjacket. Thin sections of these, when photographed in the electron microscope, reveal the enlarged nucleus containing a central body, which is often shaped like a horseshoe. Around this is a second or pericentral body, while outside this again is a less dense zone in which many virus rods can be seen.

We know, therefore, from our studies so far of these nuclear virus diseases, that almost all the chromatin of the infected nuclei is organized into a central virus-producing chromatic mass or net which has a large surface area.

Viruses in the Control of Insect Pests

There is a practical aspect to the study of insect viruses, and mention must be made of the possibility of using them to control noxious insect pests. So far, the method used has been to breed numbers of the caterpillar pest in question and infect them with a polyhedral virus disease to which they are susceptible. By this means a great quantity of polyhedra can be obtained, and these are used to start an artificial epidemic. This method has been used with success in California and Canada[8,9]. These were cases of controlling an insect pest by artificial propagation of a natural infection. We hope, however, to take the matter further by providing a virus to attack an insect pest which does not suffer naturally from a virus disease. We have shown recently that, contrary to accepted opinion, the polyhedral viruses of insects are not so specific in their action as was thought, and that cross-infection is quite possible. Using a combination of two viruses originally obtained from caterpillars of the painted lady butterfly (*Vanessa cardui*), we have infected a large number of different species of caterpillars. Some experiments in the control of two well-known insect pests have been made, using the same combination of viruses. The pests in question are the caterpillars of the winter moth (*Operophtera brumata*) and the pine looper (*Bupalus piniarius*). Foliage of apple and pine needles contaminated with the two polyhedral viruses were fed to the larvæ. The results were quite surprising; 75 per cent of the winter moth caterpillars and 100 per cent of the pine loopers were killed by a polyhedral disease. Examination of the dead larvæ showed that they had died of a cytoplasmic virus disease of the gut. So far as this goes, it is satisfactory; but the experiments have still to be made on a large scale out-of-doors, and methods of biological control are liable to go wrong because there are so many variable factors.

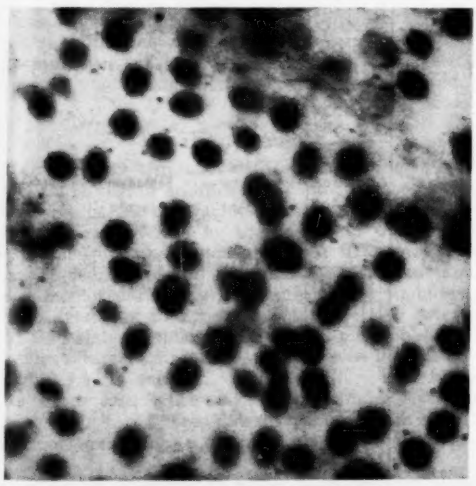

Fig. 3. Section through some of the virus particles shown in Fig. 2; note the darker centres in some cases, suggestive of a composite nature. × 42,000

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KAFUAN STONE ARTEFACTS IN THE POST-AUSTRALOPITHECINE BRECCIA AT MAKAPANSGAT

By C. K. BRAIN, Prof. C. VAN RIET LOWE and Prof. R. A. DART

Discovery and Geology

DURING October 1954, the main breccia sections at Limeworks, Makapansgat, South Africa, were sampled for mineralogical analysis. The profile of one of the most complete and interesting of these sections is reproduced in Fig. 1.

The 15-ft. thick deposit of light pink breccia, which rests directly upon the basal travertine, has been referred to by Dart[1] as the australopithecine-bearing "grey white clays". Afterwards King[2] termed it the "Older Red Sand". A heavily calcified deposit, it contains numerous weathered dolomite blocks, as well as a band of rounded water-worn pebbles at the 40-ft. level. The layer as a whole can be regarded as a contaminated stalagmite, and certainly represents a very slow accumulation. It is followed in sequence by 35 ft. of what has been described as calcified "loess" by Bosazza, Adie and Brenner[3] in 1946 and by Dart[1] in 1947. A careful examination of this material, however, has shown that the term 'loess' certainly cannot be applied. Throughout the greater part of its depth, this layer consists of a calcified soil containing very numerous pieces of rock. Almost without exception these rock pieces show signs of abrasion typical of river action, while many of them have been very effectively rounded. This fact, together with the presence of water-worn quartzite pebbles derived from higher up the Makapan Valley, clearly indicates that one is dealing here with a coarse river aggradation deposited inside the cave at a time when its opening was close to river-level. The present elevation of the surface of the deposit above the modern river-bed is 160 ft. Considering, then, that the original cave entrance must have been rather above the present surface of the deposit, some impression is gained as to the amount of erosion which has occurred since the whole deposit was laid down.

The conclusion that part of the Limeworks cave-filling represents a river gravel is a significant one. But more significant still is the observation that this gravel contains stones showing unmistakable signs of artificial fracture. In view of this fact it becomes vital to establish the relationship between the gravel bed and the underlying australopithecine-bearing breccias.

At Limeworks, the greatest concentration of bone is to be found in the heavily calcified breccias resting directly upon the travertine floor. It is from these that all the australopithecine fossils have been obtained. Mineralogical study has shown that these breccias contain a large proportion of residual cave material, and that they formed very slowly at a time when the cave opening was small. The great length of time required for their formation accounts for the concentration of bone within them. These bone-rich strata may be correlated with the 'light pink breccia' in Fig. 1. The transition at the 35-ft. level from this breccia to the less heavily calcified gravel represents the first rapid introduction of outside material through the suddenly enlarged cave entrance. It is therefore my opinion that the section shown in Fig. 1 can be regarded as a single phase of accumulation, and that no major temporal unconformity occurs at any point. This conclusion was first reached on faunal grounds by Cooke[4] in 1947 when he wrote: "On the percentages of extinct and living forms and the number of identical species present in the lower, middle and upper zones of the Limeworks Quarry, it is clear that there is no very great difference in age between these zones". This means, therefore, that there can be no very great age difference between the gravel deposit and the australopithecine-bearing breccia.

Consideration will now be given to the relative dating of Limeworks in comparison with the other Transvaal australopithecine sites. It has been found that the most profitable approach to the problem of relative dating of the cave deposits is through an estimation of the past climates which prevailed at the times of their accumulations. Such an estimation has been made possible by various mineralogical and analytical means which will be described in detail elsewhere. The most direct of these is through percentage abundance determinations of wind-rounded sand grains in the breccia sands. If the necessary precautions are taken, such determinations provide a direct clue to the dryness of the conditions prevailing at the times in question.

The climatic deductions considered in conjunction with the faunal successions for the various sites have led to the establishment of the following sequence in time, which reads from the bottom up:

Dryness	Site
Minimum—increasing	Kromdraai (2 sites)
Decreasing	Swartkrans
Maximum	Sterkfontein

In his paper on the dating of the australopithecines, Oakley[5] places Limeworks slightly earlier than

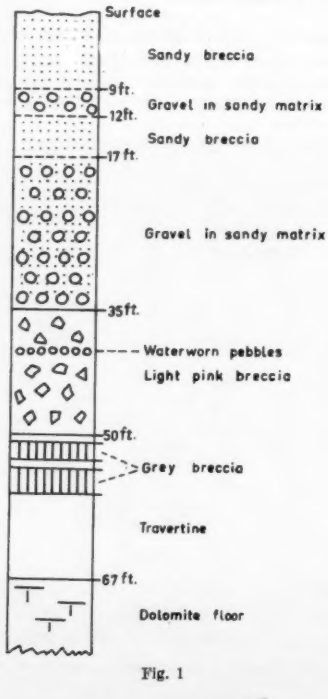

Fig. 1

Sterkfontein; but the climatic indications now obtained from Limeworks show it to fall more readily somewhere between Sterkfontein and Swartkrans, but almost certainly overlapping the latter to some extent. This conclusion is supported by the faunal evidence. In considering the baboon genera *Simopithecus* and *Papio*, recent, and as yet unpublished, work by Freedman has shown that neither occurs at Sterkfontein, that the former is present at Limeworks, while both have been obtained from Swartkrans. Likewise, *Equus* does not occur at Sterkfontein but has been found at both Limeworks and Swartkrans.

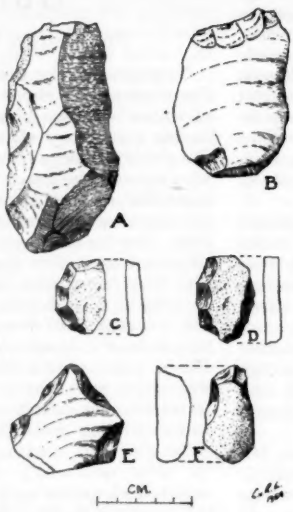

Fig. 2

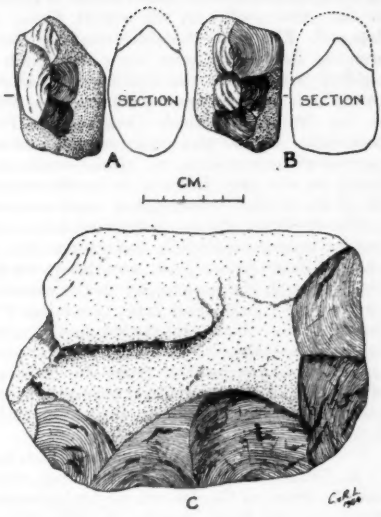

Fig. 3

The complete evidence for the position of the sequence Sterkfontein – Limeworks – Swartkrans – Kromdraai in the Pleistocene time-scale will be considered in detail elsewhere. It may be stated, however, that this evidence is not in full agreement with Oakley's[5] Kageran–Kamasian date for the sites, but tends to indicate both their greater antiquity, and the presence of an extra pluvial period to which no African stage-name can at present be applied.

To sum up, it has been suggested that in the Limeworks deposit one is dealing with a coarse river aggradation superimposed directly upon the australopithecine horizon; that there is no significant temporal unconformity between these horizons, and that the whole succession is comparable in age with the Sterkfontein–Swartkrans sequence. It has also been stated that stones showing possible artificial fracture were obtained from the gravel bed. These were all taken from the basal five feet of the gravel, from, in fact, the 30–35 ft. level of the profile in Fig. 1. They come, therefore, from a position directly above the australopithecine horizon, and were submitted for examination by Prof. van Riet Lowe, whose conclusions concerning them may now be presented.

C. K. B.

The Artefacts

Of the 129 trimmed, utilized or damaged stones Mr. C. K. Brain submitted to me from the gravels that overlie the australopithecine-bearing breccias at the Limeworks site in the Makapan Valley, only seventeen are undoubted artefacts. Of these, fifteen are of deeply leeched dolomite, one of vein quartz and one of dark grey quartzite. They include ten flake artefacts, four pebble artefacts, two artefacts on thin slabs of dolomite and one split pebble.

The artefacts on flakes include those illustrated in Fig. 2 (*A*, *B* and *E*). *A* and *B* were struck from cores only *after* other and possibly similar flakes had been struck. *B* was later trimmed into an end-scraper, and *E* into a double-notch-and-tooth type of tool.

The four artefacts on water-worn pebbles include the two tools illustrated in Fig. 3 (*A* and *B*), the large core shown in Fig. 3 (*C*) and the split pebble illustrated in Fig. 2 (*F*). *A* and *B* are as typical of the Oldowan as they are of the Kafuan Culture, but *F* is decidedly Kafuan.

At least seven flakes were deliberately removed from the large core (Fig. 3, *C*): five in one direction, in the typical block-on-block manner, and two in the opposite direction.

The artefacts on thin slabs of dolomite (Fig. 2, *C* and *D*) show steep secondary, almost vertical, trimming around their peripheries in the best 'Hope Fountain' manner.

The split pebble (Fig. 2, *F*) was split longitudinally down its major axis in the manner of an ortholith and trimmed into a beaked or rostro-carinate form (Stage I) typical of the Developed Kafuan Culture[6].

On the evidence before us, this assemblage can only be assigned to the Developed Kafuan Culture as this occurs in Uganda and in the disturbed upper layers of the Basal Older Gravels in the 200-ft. terrace of the Vaal River at Klipdam[7].

The discovery of Kafuan-type artefacts in a terraced river gravel in an undisturbed stratified sequence of deposits immediately overlying australopithecine-bearing breccias in a cave is unique. When we add to this the known occurrence of Chellean- and Acheulean-type tools that cover the full range of the great African Hand-axe Culture of the Earlier Stone Age of Middle Pleistocene times in more recent deposits in, and in the immediate vicinity of, this amazing valley, some in caves and some in exposed sites, followed stratigraphically by Middle and Later Stone Age remains of Upper Pleistocene and Holocene times, we are encouraged to hope that the establishment of a Quaternary chronology independently of any set up elsewhere is, among other things, now well within our reach.

C. v. R. L.

General

Nearly thirty years ago the Makapansgat Limeworks bone breccia was recognized as a site of early human occupation[8]. Twelve years later, Early Stone

Age implements were found about a mile farther up in the same valley in the sealed Cave of Hearths deposit[9]. The general stratification of the Limeworks breccia, the basal grey layer of which afterwards yielded repetitive discoveries of *Australopithecus prometheus* and the concomitant fauna, was described at the first Pan-African Congress on Prehistory at Nairobi[1]. Up to the present time, as at all other australopithecine sites, no stone artefacts have been found in the grey breccia or in the superincumbent 25–50 ft. of lime-consolidated cavern deposit.

The 40–60 ft. of consolidated and semi-consolidated cavern breccia overlying the stalagmitic floor at the Cave of Hearths has been completely excavated since 1947 through the generosity at the outset of the late Dr. Bernard Price and latterly of the Wenner-Gren Foundation. This excavation has furnished a continuous stratigraphical story of human habitation and cultural progression from the Earlier Stone Age of Middle Pleistocene times through the Middle and Later Stone Ages to the recent coming of Bantu and European.

During September and October 1954, however, Mr. C. K. Brain, in the course of the comparative mineralogical survey of the known australopithecine breccias which he has been enabled to undertake by a subvention from the Wenner-Gren Foundation, extracted from the first 5 ft. of the gravel beds overlying the grey breccia in the south-eastern section of the deposit a number of dolomite stones that appeared to him to have been intentionally flaked.

The Kafuan pebble culture of Uganda, so named by Wayland[10] from artefacts found in the terraced gravels of the westward-running Kafu affluent of Lake Albert, is the earliest and most primitive stone culture known in the African continent[6]. Farther south in Uganda it occurs in its Earliest Kafuan form in the 270-ft. terrace of the eastward-running Kagera affluent of Lake Victoria. The Developed Kafuan, while the oldest and most primitive stone culture known in South Africa, first appears in Uganda in the later 200-ft. terrace of the Kagera River (*vide* ref. 6).

The only implemental evidence hitherto found accompanying australopithecine remains are the fractured and worn bones, jaws and horns, that Dart claimed as the by-products of their predatory habits. This discovery of Kafuan-type artefacts in a gravel bed in a stratified sequence of deposits immediately overlying the grey stratum, which nearby in the same cavern system is an australopithecine-bearing bone breccia, is unprecedented. It opens up the astonishing prospect that Makapansgat may place within our grasp in a single South African valley a continuous story of human handiwork and a consecutive chronology of mankind from the dawn of the Pleistocene to the present day. R. A. D.

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[3] Bosazza, V. L., Adie, R. J., and Brenner, S., *J. Natal Univ. Coll. Sci. Soc.*, 5 (1946).

[4] Cooke, H. B. S., Proc. Pan African Congress on Prehistory, 1947, p. 26 (1952).

[5] Oakley, K. P., *Amer. J. Phys. Anthrop.*, **12**, 9 (1954).

[6] Van Riet Lowe, C., "The Pleistocene Geology and Prehistory of Uganda", Part 2: Prehistory. Geol. Survey Uganda. Memoir No. VI (1952).

[7] Van Riet Lowe, C., S. Afr. Archæol. Bull., No. 30, Vol. 8, pp. 27–31 (1953).

[8] Dart, Raymond A., *S. Afr. J. Sci.*, **22** (1925).

[9] Van Riet Lowe, C., *S. Afr. J. Sci.*, **35**, 371 (1938).

[10] Wayland, E. J., "Some Primitive Stone Implements from Uganda" (Govt. Press, Uganda, 1923).

OBITUARY

Prof. Enrico Fermi, For.Mem.R.S.

The news of the death on November 28 of Enrico Fermi came as a shock to his numerous friends, many of whom had seen him only a few months previously in his customary strength and good humour. By the public at large he will be remembered as the man who opened the gates to the atomic age: he led the team which, on December 2, 1942, produced the first self-sustained nuclear chain reaction—the first 'atomic pile'. But he had been a leader in the field of nuclear physics long before that. A few months after Irène and Frédéric Joliot had discovered artificial radioactivity in 1934 he showed, with his collaborators at the University of Rome, that neutrons can be used to produce radioactive isotopes of nearly all nuclei. For a year or two thereafter any nuclear physicist who could read Italian was in great demand—he had to translate the short communications which appeared in the *Ricerca Scientifica*, nearly every one revealing some new and startling phenomenon. The discovery of 'slow neutrons', of their strong absorption in selected elements such as cadmium, their ability to disintegrate boron, releasing energies millions of times their own; their diffusion in paraffin wax; the selective absorption of different neutron 'groups' in different elements: seldom has there been such an explosive outburst of brilliant, wholly unexpected discoveries.

Of special significance was the observation that neutron bombardment of uranium caused the formation of active products which Fermi thought were trans-uranic elements. In this he was wrong; they were fission products, elements lighter than uranium, but this was not realized until four years later. So it might be said that Fermi was the first to cause and observe nuclear fission, though he did not recognize it.

All this was the work of a superb experimenter, quick to design relevant tests with simple means, yet equally capable of conducting the wide-flung research and development which led to the first atomic pile. These achievements alone would have secured Fermi an honourable place in the history of experimental physics.

But actually Fermi started his career as a theoretician; and it is for his work in theory that his name will be remembered through household words such as the Fermi statistics, the Fermi theory of beta-decay, and the 'fermion' (any particle which obeys Fermi statistics). It was in 1926 that he applied Pauli's exclusion principle to systems of many identical particles (Dirac did the same independently a little later), and developed the peculiar kind of statistical mechanics required to describe the thermal properties of such systems. In ordinary gases the deviations from 'classical' statistics are irrelevant except at very low temperatures. But Fermi statistics gave the clue to the behaviour of electrons in metals: here was a 'gas' for which even white heat represented a very low temperature, and a great many puzzling facts—such as the absence of any considerable contribution from the conduction electrons to the specific heat—fell into place when Sommerfeld (1928) used Fermi statistics to create the modern theory of electrons in metals.

Fermi's theory of beta-decay was published in 1934. Again it was based on an idea of Pauli: the idea of postulating a 'neutrino'—a light, neutral and

practically unobservable particle—to account for the variable amounts of energy missing in beta-disintegrating processes. The theory was immediately successful: it accounted for most of the facts then known and predicted new ones which were duly verified. Some refinements—which fitted naturally into the original framework—were added later, and it is now certain that Fermi's theory gives a correct account of all aspects of the beta-process—the mutual transformation of protons and neutrons—though the place of this process in the general scheme of things is still one of the main mysteries of to-day's physics.

After the War, Fermi returned to academic work at the University of Chicago. The atomic piles he had created were powerful sources of neutrons, and he used them in the experimental attack on fundamental problems, in particular that of the interaction of neutrons and electrons. But he did not neglect theory: his work on the origin of the cosmic radiation (1947), on the production of multiple mesons (1950) and on the interpretation of meson-scattering experiments at the big new synchro-cyclotron was witness to the unabated vigour of his mind.

Born in 1901, Enrico Fermi was quick in establishing his position: professor in Rome by 1928, member of the Accademia d'Italia in 1929, Nobel Prize in 1938. Since 1938 he had lived in the United States, with his wife and two children.

Fermi's strength was not subtlety or high-flown imagination, but strong common sense combined with perfect mastery of his subject. No vagueness or mysticism for him: the essence of his work was clarity. His papers were written in a style so crystal-clear that the tremendous intellectual effort which had created them was out of sight. His lectures were perfectly planned and delivered with the skill and humour of a showman. His personality, unassuming yet dominant, often provocative but always tolerant, forceful and yet easy-going, will be remembered by all who met him. His joy of living was contagious, and his death is a great loss both to the world of physics and to his many friends all over the world.

O. R. Frisch

NEWS and VIEWS

Directorship of the Royal Horticultural Society's Gardens: Dr. H. R. Fletcher

Dr. H. R. Fletcher, director of the Royal Horticultural Society's Gardens at Wisley, has been appointed to succeed Dr. J. M. Cowan as assistant to the Regius Keeper of the Royal Botanic Garden, Edinburgh. Dr. Fletcher graduated at Manchester in 1929 and in the same year was appointed assistant lecturer in botany in the University of Aberdeen under the late Prof. Craib. There he became interested in taxonomy, especially in the flora of Siam. After taking the degree of doctor of philosophy, he was appointed to the staff of the Royal Botanic Garden, Edinburgh, in 1934. There he continued his work on the Siamese flora and graduated doctor of science in 1939. In collaboration with Sir William Wright Smith he has published a long series of papers on the sections of the genus *Primula* in the *Transactions of the Royal Society of Edinburgh*, the *Transactions of the Botanical Society of Edinburgh* and in the *Journal of the Linnean Society*. Then followed a revision of the genus *Omphalogramma* and numerous articles in scientific and horticultural journals on the genera *Codonopsis*, *Cremanthodium*, *Aconitum*, *Potentilla* and *Incarvillea*. In 1951 Dr. Fletcher left Edinburgh to become director at Wisley. After some four years there, he is again strongly attracted to the line of work he pursued for so long at Edinburgh and is returning there shortly.

Mr. F. P. Knight

Mr. F. P. Knight, who is to succeed Dr. Fletcher as director at the Royal Horticultural Society's Gardens, is a Devonian, fifty-two years of age, who commenced his horticultural career in 1915 at Werrington Park, Launceston, Cornwall, at that time owned by Mr. J. C. Williams, who did so much to support George Forrest in his botanical exploration work in Western China. During 1919–23 Mr. Knight was a probationer gardener in the Royal Botanic Garden, Edinburgh, where he worked mainly in the Propagating Department, and helped with the experimental work on plant propagation from cuttings. The experience gained laid the foundation of Mr. Knight's favourite branch of horticulture. After a period of nearly two years as a student gardener at Kew, he was for four years in charge of the Arboretum nurseries there. This was followed by a period with Messrs. Baker's, of Codsall, Wolverhampton, where he specialized in the commercial production of large quantities of rock garden plants, and also supervised the firm's landscape planting activities for two years. He then went to Knap Hill Nursery, Ltd., Woking. In 1940 Mr. Knight was appointed horticultural officer to the Directorate of Camouflage, Ministry of Home Security, becoming senior officer as the work developed. In April 1944 Mr. Knight joined Messrs. R. C. Notcutt's Nursery, Woodbridge, as general manager, and in 1945 was appointed managing director. Mr. Knight has been active in the Royal Horticultural Society, serving on the Society's Floral Committee and the Camellia and Rhododendron Committee. He has been a member for several years of the Technical Sub-Committee of the Roads Beautifying Association.

American Society of Tropical Medicine and Hygiene: Awards

The following awards were recently presented at a meeting of the American Society of Tropical Medicine and Hygiene:

LePrince Award to Prof. B. G. Maegraith, professor of tropical medicine in the University of Liverpool. The award consisted of a medal and a prize of 500 dollars contributed by the Michigan Chemical Co. Mr. J. A. LePrince, after whom the award is named, also received the medal, which had not been struck at the time he was first honoured by the National Malaria Society.

Bailey K. Ashford Award for research on chemotherapy of malaria and amœbiasis to Dr. Joseph Greenberg, of the Laboratory of Tropical Diseases, National Microbiological Institute, National Institutes of Health, Bethesda, Maryland. The award is given to a scientist less than thirty-five years of age and consists of a medal and a prize of 1,000 dollars, furnished by Eli Lilly and Co., Indianapolis, Indiana.

Theobald Smith Medal to Dr. George Cheever Shattuck, professor emeritus of tropical medicine at Harvard University.

The Charles Franklin Craig Lecture was given by Dr. Albert B. Sabin, research professor of pediatrics, University of Cincinnati Medical School.

Institute of Metals: Medal Awards

The Institute of Metals has awarded the following Medals: *Institute of Metals* (*Platinum*) *Medal*, for 1955, to Dr. C. J. Smithells, director of research of the British Aluminium Co., Ltd., Gerrards Cross, in recognition of his services to metallurgical science, to the metal industries and to the metallurgical profession; *Rosenhain Medal*, for 1955, to Dr. W. A. Baker, research manager of the British Non-Ferrous Metals Research Association, London, in recognition of his outstanding contributions to knowledge in the field of physical metallurgy, with special reference to the influences of gases and shrinkage on the soundness of cast metals; *W. H. A. Robertson Medal and Premium*, for 1954, to Prof. H. Ford and Mr. J. G. Wistreich, for their paper on problems of the control of dimensions, shape and finish in the rolling of sheet and strip and in the drawing of wire (*J. Inst. Met.*, **82**, 281; 1954).

Polarographic Society: Inaugural Meeting

The inaugural meeting of the Polarographic Society was held on November 9 in the Lecture Theatre of the Pharmaceutical Society of Great Britain, 17 Bloomsbury Square, London, W.C.1, with Mr. W. J. Parker in the chair. The meeting was attended by more than forty people interested in the subject, who had come from many parts of Britain. Mr. Parker reviewed the steps leading to the formation of the Society. According to the constitution, the objects of the Society are "to advance and promote the science of polarography in all its aspects and to provide educational facilities in polarography through discussion and any other medium". He said that the Society also hopes to facilitate the discussion of day-to-day problems as well as further an understanding of the basic principles. In referring to the enthusiastic support given to the new Society by the "polarographic profession", Mr. Parker stressed that membership is open to any person interested in the objects of the Society; the annual subscription has been fixed at 10*s*. Four papers were then presented which in themselves epitomized the objects of the Society: they were "A Brief Introduction to Polarography", by Dr. A. L. Glenn, lecturer in pharmaceutical chemistry in the School of Pharmacy, University of London; "The Polarograph with Derivative and Phase Selective Additions", by G. L. Young, Research Department, Cambridge Instrument Co., Ltd.; "Potential Pitfalls in Practical Polarography", by Mrs. B. Lamb, chief chemist of Tinsley (Industrial Instruments), Ltd.; and "The Application of Polarography to Pyrimidine Chemistry", by Mrs. N. Luthy, of Stanford University, Stanford, California (now working at the University of Manchester on a grant from the British Empire Cancer Research Fund). Further information about the Polarographic Society can be obtained from V. S. Griffiths, Chemistry Department, Battersea Polytechnic, London, S.W.11.

Courses in Advanced Technology in Britain

Following up the statements in Parliament on higher technological education (see p. 22), the Minister of Education, Sir David Eccles, gave in a written answer on December 14 the names of twenty-four technical colleges in which courses in advanced technology had been approved for an increased grant of 75 per cent under Circular 255. Eight of these are in London. The remaining colleges include the Birmingham College of Technology, Bradford Technical College, Cardiff College of Technology and Commerce, Huddersfield Technical College, Leicester College of Technology and Commerce, Manchester College of Technology, Nottingham and District Technical College, Royal Technical College, Salford, and North Staffordshire Technical College, Stoke-on-Trent. Ninety technical colleges had applied for this grant; sixty-three had not qualified for it, and three requests are still being considered.

University of Leeds Publications and Theses during 1951–52

Under the title "Publications and Titles of Theses, 1951–2" (pp. 57; 1954; 6*d*.) the University of Leeds has issued a pamphlet listing by faculties (and including the Institute of Education, the Department of Adult Education and Extra-mural Studies, and the Library) the publications of which members of the University are authors or joint-authors, and which appeared in print during October 1, 1951–September 30, 1952. Titles of theses accepted by the University during the same period for the degrees of master and doctor are similarly listed in an appendix. There is an index of authors. It is proposed to issue similar pamphlets for subsequent academic years.

International Commission on Zoological Nomenclature: Elections

The International Commission on Zoological Nomenclature announces the election of the undermentioned zoologists to be members of the International Commission on Zoological Nomenclature, with effect from the dates stated: K. H. L. Key, principal research officer, Division of Entomology, Commonwealth Scientific and Industrial Research Organization, Canberra, in succession to Joseph Pearson (resigned) (October 15, 1954); Alden H. Miller, professor of zoology and director of the Museum of Vertebrate Zoology, University of California, Berkeley, in succession to J. L. Peters (deceased) (October 29, 1954); Ferdinand Prantl, vice-director, Národní Museum, Prague (October 30, 1954); Wilhelm Kühnelt, professor in the Zoological Institute of the University, Vienna (November 6, 1954); F. S. Bodenheimer, professor of zoology, Hebrew University, Jerusalem (November 11, 1954); Ernst Mayr, Alexander Agassiz professor of zoology at Harvard College, Cambridge, Mass. (December 4, 1954); Enrico Tortonese, professor of zoology, Istituto e Museo di Zoologia, Universita di Torino, Italy, in succession to Prof. Lodovico di Caporiacco (deceased) (December 16, 1954).

Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: D. J. Billes (senior agricultural officer, Gold Coast), assistant director of agriculture, Gold Coast; I. S. Hutcheson (agricultural officer, Bechuanaland Protectorate), director of agriculture, Bechuanaland Protectorate; E. M. Brown (senior assistant conservator of forests, Jamaica), conservator of forests, Jamaica; I. E. M. Watts (meteorological officer, Singapore), assistant director,

Malayan Meteorological Service, Singapore; H. W. Hockin (inspector of mines, Federation of Malaya), senior research officer, Department of Mines, Federation of Malaya; P. T. Nelson, agricultural officer, Nigeria; Mrs. W. M. H. Sesseler, government chemist, Gold Coast; N. V. Williams, fisheries officer, Nigeria; A. J. T. Bayles, assistant conservator of forests, North Borneo; G. J. Journeaux, assistant conservator of forests, Nyasaland; B. P. Singh, assistant conservator of forests, British Honduras; C. K. Burton and J. H. Duncan, geologists, Federation of Malaya; O. von Knorring, chemist, Geological Survey, Federation of Malaya; A. F. Trendall and J. Walsh, geologists, Uganda; W. G. C. Bearcroft, medical research officer, West Africa Virus Research Institute, Nigeria; A. R. Jenkins, senior scientific officer, East African Tsetse and Trypanosomiasis Research and Reclamation Organization, East Africa High Commission; B. A. Mitchell, scientific officer, Federation of Malaya; T. Owens, veterinary officer, Northern Region, Nigeria; W. G. C. Parker, veterinary officer, Somaliland Protectorate.

Electromagnetic Wave Theory: Symposium in Ann Arbor, Michigan

An international symposium on electromagnetic wave theory, sponsored by Commission VI of the International Scientific Radio Union and the University of Michigan, will be held in Ann Arbor at the University of Michigan during June 20–25. Five topics will be considered: propagation in doubly refracting media in wave guides (for example, ferrites); boundary-value problems of diffraction and scattering theory; work in antenna theory of fundamental importance; forward scattering; and multiple scattering (that is, of light by colloidal particles). Developments at millimetre wave-lengths will be particularly considered. Anyone wishing to read a paper should submit by March 31 an abstract of not more than two hundred words to the chairman of the symposium, K. M. Siegel, Willow Run Research Center, University of Michigan, Ypsilanti, Michigan. Further information on all other points can be obtained from J. W. Crispin, jun., at the University of Michigan, Ann Arbor, Michigan.

The Night Sky in January

Full moon occurs on Jan. 8d. 12h. 44m., U.T., and new moon on Jan. 24d. 01h. 06m. The following conjunctions with the moon take place: Jan. 9d. 03h., Jupiter 2° N.; Jan. 18d. 03h., Saturn 6° N.; Jan. 20d. 0h., Venus 6° N.; Jan. 25d. 16h., Mercury 5° S.; Jan. 29d. 05h., Mars 6° S. In addition to these conjunctions with the moon, Jupiter is in conjunction with Pollux on Jan. 24d. 21h., Jupiter 6·3° S. Mercury sets an hour after the sun on January 15 and 1h. 40m. after sunset on January 31, but is too close to the sun in both cases to be favourably seen. Venus is a morning object, its times of rising being about 4h. 20m. up to the middle of the month and 4h. 45m. at the end of the month. Its stellar magnitude varies from −4·3 to −4 and the visible portion of the illuminated disk from 0·348 to 0·528. Mars sets about 22h. 25m. throughout the month, and, as its declination increases from −5° to nearly 5°, it is becoming better situated for observation in the northern hemisphere. It is not very close to any bright star, but its eastward movement from Aquarius into Pisces is obvious during the month. Jupiter, which rises early in the afternoon (at 15h. on January 31), is visible throughout the night and morning hours, stellar magnitude −2·2. Its westward movement in Gemini as it approaches δ Geminorum is easily seen. Saturn is a morning object, rising at 3h. 45m., 2h. 55m. and 2h. on January 1, 15 and 31, respectively. Its declination is about 16° S., and it does not attain a great altitude in the British Isles; its apparent eastward movement towards γ Libræ continues until the beginning of March. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Jan. 4d. 15h. 45·8m., ζ Ari. (*D*); Jan. 6d. 21h. 04·9m., 121 Tau. (*D*); Jan. 27d. 18h. 46·0m., ϰ Psc. (*D*), where *D* refers to disappearance. The earth reaches perihelion on January 4, its distance from the sun being then a little less than 91¼ million miles. The Quadrantids meteors attain their maximum on January 3.

Announcements

Dr. S. J. Folley, head of the Physiology Department, National Institute for Research in Dairying, Shinfield, has been elected a corresponding member of the Société de Biologie of Paris.

Dr. T. Robertson, assistant director (England and Wales) of the Geological Survey and Museum since 1949, is to retire on March 31 after thirty-eight years with the Survey. He will be succeeded by Dr. F. M. Trotter, who is at present district geologist in charge of the Manchester office of the Geological Survey; and Mr. J. V. Stephens will become district geologist at Manchester.

Mr. J. Lamb, director of the Tea Research Institute, Ceylon, has been appointed director of the West African Cocoa Research Institute, in succession to Mr. J. West, who has retired. Mr. Lamb is taking up his new post in the latter part of 1955.

The Society for Psychical Research is offering a prize of £50 for an essay, preferably not exceeding three thousand words, on any topic relevant to the work of the Society. Entries close on June 30. Further information can be obtained from the Secretary, Society for Psychical Research, 31 Tavistock Square, London, W.C.1.

The Population Council, Inc., of New York, is offering further fellowships for advanced training in the study of population at the predoctoral and post-doctoral levels. Fellowships will be available for study in universities in the United States and elsewhere for the academic year 1955–56, preference being given to qualified applicants from countries other than the United States and Europe. The basic stipend of 2,500 dollars per annum may be increased by allowances for travel, dependants, etc. Application forms (to be returned by March 1) and further information can be obtained from the Population Council, Inc., 230 Park Avenue, New York 17, New York.

The Exhibition of Israeli Scientific Papers at the Israeli Consulate, 18 Manchester Square, London, W.1, which was to have closed on December 22 will remain open until January 7.

The Wellcome Historical Medical Museum, which for the past seven years has been carrying on its activities at 28 Portman Square, London, W.1, has now removed to the Wellcome Research Institution at 183–193 Euston Road, N.W.1. Exhibitions dealing with primitive medicine and with child-welfare through the ages are open to the public in the new premises (Monday to Friday, 10 a.m.–5 p.m.).

HIGHER TECHNOLOGICAL EDUCATION IN GREAT BRITAIN

IN replying to a question in the House of Commons on November 23 regarding higher technological education, the Chancellor of the Exchequer, Mr. R. A. Butler, said he had nothing to add to his statement of July 13; but when pressed with regard to the position in Wales, he indicated that he intended making a further statement which would give a broader picture than that which he had given previously. This promise was repeated by Sir David Eccles, the Minister of Education, when replying to questions on this subject, in the debate on the Queen's Speech on November 30, arising out of the reference in that Speech to the Government's intention to "stimulate the expansion of facilities for higher technological education, so that advances in scientific research may be matched by increased industrial efficiency and production". Sir David dealt particularly with questions on technical education from Mr. Malcolm MacPherson, who suggested that within the Ministry of Education a division should be set up dealing specifically with technical and technological questions. Sir David agreed that there is real urgency to treat technical education as a major problem, and he announced the lifting of restrictions as to the industries for which new technical education facilities could be provided. The amount of new work which could now be started for technical education would be increased by about £2½ million a year. He added that the Secretary of State for Scotland is also anxious to see more rapid development of facilities for technical education and will be letting the education authorities concerned have details of his proposals shortly.

The promised statement was made in both Houses of Parliament on December 7. In the House of Lords, the Lord President of the Council, Lord Salisbury, stated that the Government's plans provide for the massive expansion of the Imperial College of Science and Technology, London, and for major developments at Glasgow, Manchester, Leeds and Birmingham, including also developments on a fairly large scale at Cambridge and Sheffield, and specialized developments at other centres in Great Britain, notably at Edinburgh, Newcastle, Southampton, Nottingham and Swansea. Some of them are to be financed by industry and some by Treasury grants. The Government is endeavouring to avoid either excessive centralization or undue dispersal of resources, and is concentrating its efforts on institutions which are already receiving Treasury grants. In its view, higher technological education must be closely linked with other university studies, and those who are studying technology should work closely with those who are occupied with the more fundamental problems of science and with its application in other fields. The problems of technology are the problems of human relations as well as of science, and in training for industry the humanities have an important part to play. Where a technological institution and a university are associated, as in London, Glasgow and Manchester, this linking of studies could be achieved. If, however, new universities are to be established in other centres by upgrading the technical colleges, it will be necessary to provide them also with additional departments, and the nation cannot afford the necessary resources of teachers, buildings and money. Accordingly, Lord Salisbury indicated that the Government does not propose to start entirely new technological institutions; but it will seek close association between the universities and industry, and it has been encouraged by the recent founding of new chairs in technological subjects with funds raised from industry. Lord Salisbury added that the universities are becoming more responsive to industrial needs by designing post-graduate classes to meet particular local requirements and by inviting industry to assist with instruction.

About one-eighth of the total recurrent grants to the universities are used for technology, in the narrower sense of the term, or about £3 million a year. Additional recurrent grants for technology, amounting to £196,000, have been made for the present academic year; these will be increased to £404,000 next year and to £704,000 for the academic year 1956–57. This will be in addition to the extra cost of salaries announced in November. For building and equipment the capital expenditure and liabilities against public funds incurred in recent years for technology, in the narrow sense, now amount to about £10 million, including a number of projects authorized last July. Further building has been authorized to the extent of £1 million, in addition to the normal university building programme for the year 1955–56, and the Chancellor will be prepared to consider, for starting in the following year, other technological projects included in the University Grants Committee's plans for developments beginning in the quinquennium. The total capital cost of this project over ten years may well be about £15 million.

With regard to the expansion of the Imperial College of Science and Technology in London, Lord Salisbury stated that building work is already in progress on the northern part of the site in South Kensington to the extent of about £1·2 million, including equipment. Further progress will soon require the release of some other parts of the site from their existing use, and the Chancellor of the Exchequer has now authorized new building work to proceed in Bloomsbury to enable existing University of London activities (such as the Warburg Institute) to be transferred there in due course from South Kensington. Approval has been given for the erection of part of the north section of the British Museum (Natural History) and the completion of the new centre block of the Science Museum to release accommodation now occupied by the Aeronautical Collection of the Science Museum. To minimize the disturbance of the Indian Collection of the Victoria and Albert Museum, plans have been approved which will enable a substantial part of this Collection to be permanently on view in the main building of the Museum. Alternative accommodation will be needed eventually for that part of the Royal College of Art which is housed in the same building as the Aeronautical Collection. The Government is still considering the future of the Imperial Institute, and it is hoped to reach an early decision.

In reply to a question in the House of Commons on December 14, regarding the development of the Royal Technical College, Glasgow, into a technological university, the Secretary of State for Scotland, Mr. J. Stuart, said that the Government believed that the progress of higher technological education in Glasgow could best be served if the College and University worked out a relationship which, without hampering the development of the College, enabled their work to be co-ordinated. The Government had invited the two institutions to enter into discussions with the view of evolving a satisfactory scheme.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, INDIA

THE Council of Scientific and Industrial Research, India, was established in 1942 to administer the Industrial Research Fund, created to foster industrial development in India. The Council was charged with the promotion and co-ordination of scientific and industrial research in India, including the institution and financing of specific researches and with encouraging the utilization of the results of such researches. Its functions also include the establishment or assistance of special institutions or departments for specific studies of particular industrial problems, the award of research studentships and fellowships, the establishment and maintenance of laboratories, workshops, institutes and organizations for further scientific and industrial research and their utilization, the collection and dissemination of information and the publication of scientific papers. The development of the Council's work and its present activities are clearly and attractively set forth in a volume just issued by the Council* and which does ample justice to the energy and foresight which the Council has brought to bear for the past twelve years on problems of scientific and industrial development in India.

The development of the Council's work from that of the Industrial Intelligence and Research Bureau established in 1935 is described in an introductory chapter, including an account of the work of the Research Planning Committee appointed in 1943 and of the First Reviewing Committee of 1947, out of the recommendations of which came the National Research Development Corporation (1953) and the Board of Engineering Research (1950). The general organization of the Council, its advisory bodies and laboratories is outlined in the second chapter of the volume, and this is followed by a concise account of the work which has been carried out or is in progress in the laboratories for which the Director of Scientific and Industrial Research is responsible. The next hundred pages of the report are occupied by an account of the research programmes of the various national laboratories, which include the following (dates of opening given in brackets): National Physical Laboratory of India, New Delhi (1950); National Chemical Laboratory, Poona (1950); National Metallurgical Laboratory, Jamshedpur (1950); Fuel Research Institute, Jeelgora (1950); and the National Botanic Garden, Lucknow (1953). The total is brought to fifteen by the following institutes dealing with particular branches of applied science: Central Glass and Ceramic Research Institute, Calcutta (1950); Central Food Technological Research Institute, Mysore (1950); Central Drug Research Institute, Lucknow (1951); Central Road Research Institute, Delhi (1952); Central Electro-Chemical Research Institute, Karaikudi (1953); Central Leather Research Institute, Madras (1953); Central Building Research Institute, Roorkee (1953); Central Salt Research Station, Bhavnagar (October 1954); and the Central Electronics Engineering Research Institute, Pilani (1953). Not all these laboratories are fully working yet, as may be judged from the dates of opening.

This impressive record of work carried out or projected mainly during the past five years is followed by an account of the extensive investigations which have been or are being sponsored by the Board or the Council of Scientific and Industrial Research through its various research committees in such varied fields as scientific instruments, radio research, the ionosphere, high-altitude research, artificial rain, the measurement of geological time in India, gas turbines, the dyestuffs industry, biochemistry, malaria chemotherapy, pharmacology, the vanaspati industry, essential oils, plastics, and atomic research. Special committees have been appointed from time to time to deal with specific problems such as synthetic petrol, power alcohol from bagasse, research and development of gas turbine and jet propulsion engines in India, and low-cost housing.

Two chapters on the patent activities of the Council and the means taken to assist the utilization in industry of the results of the investigations it has sponsored and on the publications of the Council are followed by a brief note on the Indian National Scientific Documentation Centre, established at New Delhi in 1952 under the administrative control of the Director of the National Physical Laboratory. Besides some notes on the way in which the activities of the Council are financed and on its other activities, such as the co-operative research associations and the fellowships and scholarships instituted by the Council, the volume includes full lists of staff and of the personnel of the several boards and research committees, of research schemes, of patents and patent applications on behalf of the Council and of publications, including a classified bibliography of scientific and technical papers during 1940–53.

Simultaneously with this volume, the report of the Second Reviewing Committee*, constituted with Sir Alfred Egerton as chairman to report on the activities of the Council during the past five years, has been published; while the development of the Council's work has clearly been influenced by the experience of the Department of Scientific and Industrial Research in Great Britain, it is equally clear that there has been no slavish copying but that attempts have been made to shape both the organization and activities in accordance with Indian needs and conditions. The Reviewing Committee records the considered opinion that the twelve very fine modern laboratories which have been built are well sited and designed and have been well equipped at a very reasonable cost and that, except for certain important developments to which the Committee directs attention, they cover a range of research in science and industry which appears to be adequate for the next four years, although expenditure on research in India is far from being on the scale of highly industrialized countries, such as the United States or the United Kingdom. Recurrent grants to the Council from the Central Government have increased from 1,100,000 rupees in 1942–43 to 17,350,000 rupees in 1953–54, recurrent expenditure increasing from 695,611 rupees in 1942–43 to 12,928,765 rupees in 1952–53.

The policy of the Council in establishing these national laboratories and institutes has, in the Committee's opinion, been fully justified; the directors have been well chosen, the staffs are keen and are doing good work. The Reviewing Committee does not recommend any reorganization, but it makes some suggestions to improve the efficiency of operation and co-ordination. For example, the

* Council of Scientific and Industrial Research, India. A Review. Pp. 142. (New Delhi: Council of Scientific and Industrial Research, 1954.)

* Report of the Second Reviewing Committee of the Council of Scientific and Industrial Research. Pp. viii+98. (New Delhi: Council of Scientific and Industrial Research, 1954.)

directors should be given as much freedom as possible in administration, with more time to exercise scientific guidance; the number of research committees—at present twenty-five—should be kept within bounds, and committees should be terminated when their work does not warrant two or three meetings a year; and further consideration of the relations between the national laboratories and institutes and the universities is recommended so as to ensure that the whole scientific organization operates in concert.

There are sensible suggestions for co-operation in this field, including the interchange of facilities and of staff and welcoming the establishment of a University Grants Commission to provide grants for ensuring salary scales to attract staff of high quality, and the Committee stresses the importance of encouraging research at the universities and higher technological institutes. Emphasizing equally the importance of co-operation with industry, it recommends that the liaison officer at the Council's headquarters should be responsible for furthering all such collaboration between the Council's institutes and laboratories and other research organizations. Special attention is directed to the need for closer co-ordination and co-operation between the Council and the medical and agricultural research services, and more active co-operation with government departments is also recommended to facilitate utilization of the results of research carried out under the Council. For the same purpose, as much help as possible should be given to the National Research Development Corporation, and the institutes should be assisted to establish pilot plants.

The Reviewing Committee favours the establishment of further research associations where the size of an industry would justify this procedure, and it is obvious that, with regard to the utilization of research results, the dissemination of information, development and the formulation of research programmes, experience in India is not dissimilar from that in Britain. The Committee's remarks as to the way in which the Council could give the measure of direction to the research done under its ægis necessary to ensure that it is related to India's needs and to the general advance of science are of considerable interest. Ideas, it recognizes, must come mainly from the centres of research and, as research programmes, or less formally, they are discussed at meetings of the Council's research committees. At this stage they should be related to the general plan for India and to the state of science and technology; and the Reviewing Committee suggests that the principal executive officer and director of the Council should be able to call together such members of the Advisory Board, directors and advisory committees of the laboratories and others from medical or agricultural research or the universities as would be needed to assess the importance and priority of particular ideas, and to suggest suitable laboratories within or without the organization where the research could be initiated. He would thus be enabled to present to the Advisory Board of the Council a directive in relation to the programme which is submitted to the Board for review at least twice a year.

The developments which the Reviewing Committee considers desirable to complete the Council's cover of India's requirements are the Institute of Mining Research and the Central Mechanical Engineering Research Institute, both of which are to be established, the latter at Calcutta, mainly through private benefaction, and in this connexion the Committee comments on the need to attract young engineers to undertake research. It has also been agreed to accommodate a Telecommunications Research Institute in the National Physical Laboratory, where the Defence Science Laboratory is also temporarily housed. It recommends that full opportunities should be given for astronomical research in India, so as to utilize the ability for mathematical analysis and physical investigation for which Indian scientific workers are particularly noted, and that the Council should at least foster astronomical research in the universities and other centres. The proposal to establish meteorological stations is welcomed and a centre for geophysical research is also recommended.

Provision for atomic energy is regarded as adequate, but some concentration of research effort on the utilization of solar energy, either direct or by chemical or biochemical means, is recommended, as well as further attention to the de-salination of water and concerted efforts to conserve, improve and recover the soils of India. Physiological research requires full attention, and genetics also needs adequate cover. The Committee concludes its report with a tribute to the work already accomplished in so short a time and to the ability of the Council's chief executive officer, Sir Shanti Bhatnagar.

DEEP-WATER MOVEMENTS IN THE OCEAN

MUCH less is known about water movements in the depths of the oceans than about surface currents. The oceanic circulations, however, involve movements of water at all levels, with vertical as well as horizontal components, so that the movements in the various layers are to some extent dependent on one another. Deep-water movements are therefore of interest to meteorologists as well as to marine physicists, biologists and geologists.

A Geophysical Discussion on this subject took place at a meeting of the Royal Astronomical Society on October 22. Dr. G. E. R. Deacon (National Institute of Oceanography), who was in the chair, referred to a quotation from Croll, towards the end of the past century, to the effect that the cause of ocean circulations was a question belonging to the domain of physics and mechanics, whereas few physicists or mathematicians of note had given much attention to it; this, he said, is no longer true. The contributions to the Discussion, continued Dr. Deacon, would show evidence of various ways in which problems of oceanic circulation are being tackled theoretically and by laboratory experiments as well as by observations in the oceans themselves.

In the first paper, Prof. K. F. Bowden (University of Liverpool) gave a brief account of the main features of the oceanic circulation below the surface layers, as deduced from the observed distributions of temperature, salinity, oxygen content and other properties. He referred to various estimates which have been made of the velocities of the deep-water movements, such as those based on the balance between horizontal flow and vertical or lateral mixing, and particularly to the charts of currents at 800 m. and 2,000 m. in the Atlantic Ocean deduced by Defant on the basis of the absolute dynamic topography. Most estimates agree in order of magnitude, giving the velocity of flow of the Antarctic

Bottom Water, for example, as about 1 cm./sec., so that it would take about twenty years to travel from the Antarctic to the Equator. Estimates by carbon-14 dating technique, however, have given a time as long as eighteen hundred years, while photographs of sand ripples have suggested currents greater than 15 cm./sec. at the bottom. The direct measurements which have been made to date have been in some cases in agreement and in others in disagreement with the estimates. The difficulties of using a current meter from an anchored ship lead to possible errors of measurement which may, in some cases, be comparable with the deep currents themselves. New methods and techniques, some examples of which were given by subsequent speakers, are needed in the study of deep currents.

The next two papers were of a theoretical character, and both were concerned with currents due directly or indirectly to the stress of the wind on the sea surface. Dr. E. T. Eady (Imperial College of Science and Technology, London) gave a critical account of recent theories of the wind-driven large-scale circulations, which have shown that the concentration of flow towards the western sides of the oceans arises as a consequence of the variation of the vertical component of the earth's rotation with latitude. The basis of such theories, as developed by Stommel and Munk, is the integrated vorticity equation, from which it may be inferred that, in a steady state and in the absence of stresses on the 'sides' of a vertical column of water due to turbulent motion, the mean north–south motion of the column is proportional to the external torque, presumably due almost entirely to wind stresses on the surface of the ocean. The reason is that the rate of (absolute) rotation of the column must be almost the same as the vertical component of the earth's rotation, and this increases with latitude. Since the external torque is mainly a function of latitude and all the water cannot move north or south, it is necessary to assume that short-range turbulent stresses play an important part in a narrow region on the western side of the ocean, where there is a strong narrow current in the opposite direction to the drift elsewhere. A difficulty in interpretation is that we do not know the mean currents, measurements of density gradient yielding only relative currents. As a step towards a more detailed theory, Dr. Eady showed that, if we suppose that the turbulent motion which transmits the surface stresses downwards is limited to a rather shallow layer, then there must be convergence in this layer near latitude 30° which forces down the light surface water. There are, however, difficulties in applying such a simple theory in low latitudes.

Dr. W. V. R. Malkus (Woods Hole Oceanographic Institution, U.S.A.) gave an account of a treatment representing an extension of work by H. Stommel, which was based on the assumption of a two-layer ocean, considering particularly its application to the Gulf Stream. The two layers, of different temperatures, and hence of different densities, are separated by an interface of variable depth which meets the surface in a line corresponding to the cold northern edge of the Gulf Stream. The surface layer is assumed to be in geostrophic balance and its vorticity conserved. Dr. Malkus gave a solution for the depth of the upper layer as a function of latitude and the transport by the current in the upper layer for a given distribution of wind stress. He suggested that momentum is lost from the Gulf Stream by eddies which break off from the meanders, the momentum being dissipated in the cold water to the north of the current and the heat lost by radiation and evaporation to the atmosphere. Assuming that half the momentum of the Gulf Stream is lost in this way, and taking the appropriate temperatures for the two layers, a reasonable solution may be obtained for the loss of heat energy and for the depth of the interface. For a transport corresponding to the wind stress curl as observed, the maximum depth is 800 m. Dr. Malkus suggested further that the water lost from the surface layer in this way returns as a deep current, with a velocity which would be about $\frac{1}{8}$ cm./sec. if distributed over 3,000 m. of depth. This might be re-incorporated in the surface layer in lower latitudes by the deepening of the thermocline by about 50 m., which occurs in the winter months.

Mr. T. V. Davies (King's College, London) dealt with a possible experimental approach on the model scale, referring to the 'dish pan' experiments of Fultz in Chicago and Hide in Cambridge, which were designed to study motions in the atmosphere on the rotating earth. In the experiments, a liquid is contained in the annular space between two concentric cylinders, which are rotated about their common axis. Heat is supplied at the outer boundary while the inner boundary is cooled, corresponding to the heating of the atmosphere in the equatorial region and cooling near the poles. The flow régime depends, other things being equal, on the angular velocity of rotation. For low rates of rotation, the water particles rise near the outer boundary, move inwards near the surface, sink near the inner boundary and flow outwards below in a uniform manner. This has been called the 'Hadley régime'. When the rate of rotation exceeds a critical value, another system of flow, known as the 'Rossby régime', sets in, in which the surface flow becomes concentrated into wave-like paths, similar to the 'jet streams' which occur in the upper atmosphere. Mr. Davies presented the theory on which these experiments are based, starting from the equations of motion, continuity and heat transfer, and arriving at three parameters governing the motion, by which the transformation from model to full-scale flow should be carried out. The values of these parameters for the ocean are of the order of a hundredth of those for the atmosphere, but they should be within the range readily attainable in experiments. The type of motion studied hitherto derives its energy from thermodynamic processes, which are predominant in the atmosphere. Mr. Davies pointed out that the surface stresses, which are important in the case of the oceans, have not been represented, but suggested that they might be included by using two layers of liquid in the experiments.

In the last contribution, Mr. J. Crease (National Institute of Oceanography) returned to full-scale observations in the ocean, describing some results obtained by three different methods during last May and June in R.R.S. *Discovery II*, working in an area between Spain and the Azores, about 42½° N., 20½° W., in a depth of about 4,000 m. In the first method, a deep drogue constructed of two steel frames 6 ft. square, in the form of a cross, and covered with canvas, was suspended by piano wire from a pair of small elliptical floats. Two such drogues, one at 1,000 m. and the other at 2,000 m., were tracked for several days, their positions being fixed by radar from the ship, relative to a marker buoy moored by piano wire to a sinker on the bottom. Both indicated

a flow directed approximately towards the east-north-east, the drogue at 1,000 m. averaging about 0·2 knot (about 10 cm./sec.) and that at 2,000 m. about 0·1 knot. The second method consisted of taking normal hydrographic stations down to 3,000 m. at the four corners of a square of 10 miles side, and computing the velocity perpendicular to each side of the square relative to that at 3,000 m. The results indicated an apparent flow into the square across one pair of opposite sides and outwards across the other pair of sides. Mr. Crease suggested that this surprising result might be due to tidal changes in the slopes of the isobaric surfaces, the whole four stations having been occupied in a period of a little more than twelve hours. The third method employed a new technique, analogous to the use of an inverted radiosonde. A supersonic transmitter, emitting a 'ping' every few seconds, was attached to a type of parachute, so that it sank slowly through the water at a rate of about 250 m./hr. Its position was fixed at intervals by sound-ranging, the pings being received by four hydrophones, one suspended below the ship and the other three below sono-radio buoys, which were moored to the bottom by piano wire, and which transmitted the received signals to the ship. The relative positions of the buoys and the ship were fixed by radar. The results showed a current in the same direction as that indicated by the drogues, but of a greater magnitude: about 0·5 knot down to 1,200 m. and decreasing at greater depths.

The discussion which followed reflected the interest aroused in the new theoretical and experimental approaches. In reply to suggestions on the sinking transmitter technique, Mr. Crease said that the design of a transmitter which would remain for a long period at a constant depth was being considered. Reference was made to the rotating model experiments of Von Arx at Woods Hole, Massachusetts, in which a basin of paraboloidal shape is used, providing for the variation of Corolis parameter with latitude, and boundaries having the outlines of the actual ocean boundaries in the northern hemisphere are inserted. Air streams over the model simulate the atmospheric wind systems, so that these experiments are a study of the wind-driven ocean circulation and in a sense are complementary to the 'dish pan' experiments, which have been concerned with circulations arising from processes of heating and cooling. While much remains to be learned about deep-water movements and the part they play in the general oceanic circulation, it is clear that the subject is being attacked vigorously from several angles and that encouraging progress is being made.

K. F. Bowden

LABORATORY ANIMALS IN THE UNITED STATES

"THE need for adequate standards and methods in the procurement of biological materials for research, assaying, testing and teaching"—to quote Dr. Orson N. Eaton—has been recognized for many years. The biological materials referred to are laboratory animals, and the need has, since the Second World War, become pressing in nearly every country in the world. The first action on a national scale was taken by the British Medical Research Council, which set up the Laboratory Animals Bureau in 1947. Five years later, in 1952, the Division of Biology and Agriculture of the American National Research Council, in consultation with government, university and industrial representatives, created an Institute of Animal Resources, and appointed Dr. Eaton as its executive secretary.

This was not the first American organization to make its main purpose the study of problems connected with laboratory animals. In 1950 a private and voluntary group of veterinarians and others interested in the provision and use of animals for scientific work formed an Animal Care Panel. This Panel has met every year from 1950 onwards for the purpose of receiving communications from its members, and these communications, together with the inevitable and stimulating discussions, are reproduced as proceedings. The proceedings are circulated only to members of the Panel, which is unfortunate, for much of their contents deserves wider publication; but the financial resources of the group are limited, and wider publication would presumably be beyond them.

There was a need, therefore, for the Institute of Animal Resources, with its official backing, both moral and material, and the choice of a distinguished geneticist as its executive secretary was a good one. All problems relating to laboratory animals are not genetical, and the Board of the Institute represents many other interests; but as the work of the Institute progresses, genetics will become increasingly important, and it is well that such developments can be expertly anticipated.

The work of the Institute is complementary to that of the Animal Care Panel, and since one finds that many names on the Board of one are among the membership of the other, close collaboration between the two can be assured. In addition to Dr. Eaton as executive secretary, the membership of the Executive Board of the Institute is made up as follows: P. B. Armstrong, Marine Biological Laboratory, Woods Hole; N. R. Brewer, Central Animal Quarters, University of Chicago; T. C. Byerly, U.S. Department of Agriculture; G. B. Coursen, General Biological Supply House, Chicago; A. E. Earl, Ciba Pharmaceutical Products; H. G. Herrlein, Rockland Farms; G. E. Jay, jun., National Institutes of Health; D. Jenkins, Chemical Corps Biological Laboratories; G. W. Kidder, Amherst College; C. G. King, Nutrition Foundation; W. Landauer, University of Connecticut; C. C. Little, Jackson Memorial Laboratory; R. C. Percival, Lederle Laboratories; and C. A. Slanetz, College of Physicians and Surgeons, Columbia University.

The aims of the Institute are: (1) to survey and list existing sources of animal stocks used in biological (including agricultural, medical and industrial) research, testing and assaying; and to determine the consumers and the volume of demand for such material; (2) to perpetuate this activity by taking periodic inventories and keeping a live master registry of those sources, for distribution to all interested persons and groups of consumers (for example, research laboratories, academic institutions, government agencies, industrial and trade establishments, etc.); (3) to promulgate scientific standards of definition, terminology and tolerated variability in regard to genetic constitution, nutrition, freedom from disease, housing conditions and maintenance for the major groups of animals in use; (4) to act as a liaison centre on information regarding the detection, preservation and perpetuation of new or old strains

of special importance for specific problems (for example, cancer); (5) to devise measures for ensuring adequate supplies of needed animal stocks in states of emergency (war, epidemics, etc.); and (6) to assist in the organization and facilitation of the international exchange of needed animal stocks.

The first publication of the Institute is a "Handbook of Laboratory Animals"*. This handbook has a page on genetics, by Dr. George E. Jay, jun.; a page and a half on nutrition, by Dr. Charles A. Slanetz; a page on diseases of laboratory animals, by Dr. N. R. Brewer, followed by twelve pages summarizing the more common infections of a wide variety of species; an extensive table of sources of animal supply; three pages on the uses of laboratory animals, with an extensive bibliography of uses; a short selection of general references; a table of users of laboratory animals; and a brief note on the importance and desirability of international exchange, both of information and of strains of animals of particular interest, which we in Great Britain can whole-heartedly endorse.

The main part of the handbook is occupied by the two tables, which have been compiled from the answers to questionnaires sent out by the Institute. The table of sources of animal supply is subdivided by species, and covers mice, rats, guinea pigs, rabbits, hamsters, dogs, monkeys, chicks and a wide variety of miscellaneous animals. There are columns showing strain, original source, breeding system, description, diet, disease control measures, uses and productive output, against each source of supply, which includes both laboratories and commercial breeders and suppliers. Although this list is far from complete for the country as a whole, and probably represents only a minority of total sources, it is formidable, and will undoubtedly be an immensely useful catalogue for any scientific worker wishing to select the most suitable animals for his researches. The tabulation is clear, and most of the information essentially useful. (A counterpart of this table is the "Laboratory Animals Bureau Catalogue of Uniform Strains maintained in Great Britain".) Further additions to the table have been promised, and any approach towards comprehensiveness will certainly enhance its value.

The list of uses of laboratory animals is certainly very incomplete, but, taken in conjunction with the table of sources, is a worth-while guide. Its expansion in subsequent issues would make it a useful reference index.

The second table, listing users of laboratory animals, contains information essential to the functioning of the Institute, but it is harder to see what interest it can have for others. Had it been necessary to show that the Institute was in fact well occupied, its inclusion in the handbook might have been justified, but the rest of the handbook is already sufficient evidence.

Such criticism of the Institute's work may appear ungenerous, but this would be a false impression. The Institute has undertaken a task, both of urgent necessity and of a complexity incomparably greater than in Great Britain, where the numbers of laboratories, of scientific workers and of animals used are so much smaller. It has tackled the problem with the vigour to be expected of our American colleagues, and the handbook, produced within two years of the establishment of the Institute, is ample tribute to its competence and industry. Only one who has faced similar tasks elsewhere can appreciate how much thought and work went into this enterprise, and we look forward with eagerness and confidence to further publications from the same source.

* Handbook of Laboratory Animals. (Pub. No. 317 of the National Academy of Sciences—National Research Council.) Prepared by the Institute of Animal Resources. Pp. v+77. (Washington, D.C., 1954.) 1.25 dollars.

PROFESSIONAL STATUS OF MANAGEMENT

A WELL-KNOWN management consultant, Colonel L. Urwick, discusses in a small booklet* the question as to whether management is or is not regarded as a profession, and puts forward the view that the problem is not wholly academic or a matter of words. It can have considerable influence on such questions as whether or not during the next few years Britain will be able to pay its debts or must face a falling standard of life for its people. All that is necessary to establish the claim of management to professional status is to prove that it involves some branch of learning; in other words, that there is a body of knowledge bearing on the activity of management which can be taught and learned. In 1951 there were nearly seven hundred educational institutions in the United States awarding degrees at university standard in management subjects; the number of university students 'majoring' in this field was more than 370,000, and just over eighty thousand degrees were awarded.

In Great Britain the figures were proportionately much smaller; but a number of universities have degree courses in management. An intermediate examination in management subjects has been established, and it is national policy that technical colleges should provide facilities for those who wish to prepare for it. If there is no body of knowledge bearing on management which can be taught and learned, all these activities are meaningless. On what then, asks Colonel Urwick, is the resistance to this conclusion among certain business men founded? The suggestion that management is becoming professionalized seems to many 'practical business men' to threaten with the 'theorizing' that they so much dislike the very area which they had previously regarded as the special citadel of practicality. Secondly, many men in responsible positions to-day are wholly innocent of any formal preparation for their tasks. They have learned the technique and customs of their particular trade or industry by 'experience'.

It is always difficult for the individual to resist the conclusion that the process which launched his peculiar abilities upon the community was wisely conceived. The tendency to become *laudator temporis acti* and exaggerated loyalty to 'the old school' have similar roots in the eternal fidelity of human nature to itself. The very suggestion of new and improved methods of training which will systematize and shorten the acquisition of experience seems to many a direct threat to their personal integrity.

Others again are concerned lest, if young men who have not yet won their spurs are allowed to study the art of management, they will become overimpressed with their own theoretical knowledge. There is some truth in this. Most young men under twenty-five who have had the benefit of a higher

* Is Management a Profession? By L. Urwick. Pp. 27. (London: Urwick, Orr and Partners, Ltd., 1954.)

education pass through a period when they overestimate the force of logical argument and underestimate the mutability of things. It is a condition which the older men of wisdom learn to recognize and to correct with kindly tolerance.

Another traditional attitude which plays a part in this picture, curiously at variance with our preference for the 'practical', is the British prejudice in favour of amateurishness. In business, being a director is still, in part, a stronghold of the amateur. Many men are made directors of companies who have neither worked their way up through the ranks of management nor have qualified themselves professionally in other ways. They often represent important financial interests, which should be represented, but have no knowledge of the art and science of management or of the technique of the particular industry or trade with which the company is concerned. To suggest to men who have absorbed this national prejudice in favour of amateurishness that business management should be treated as a profession seems deeply shocking.

There are certain historical reasons why the title 'director' in business has become one of the last bastions of this crumbling edifice of social prejudice. It is no accident that the highest class in the British Civil Service, that into which university graduates are recruited direct and from which the majority of the highest posts are filled, is known as the Administrative Class. The second grade, recruited from secondary-school students, is termed the Executive Class. Executive work—that is, management—commands far less social prestige in Great Britain than in the United States, where the greatest elective office in the world, the presidency, is by definition an executive office.

The proposition that management should be treated as a profession cuts across many of these quasi-understandings and habitual ways of thinking, some of them with their roots deep in British history. It means recognizing the employee, the salaried man with managerial duties, as much less sharply distinguished from the director than has been the case in the past.

Finally, in this order of objections, comes fear. In recent years the leaders of business in Great Britain have had an uneasy time. The Second World War exposed them to an orgy of government regulation from which they have not yet entirely escaped. Men who have been thus harried are bound to be sensitive beyond the normal, to feel that any suggestion that their salaried employees are going to act together—and professional status does connote some form of professional organization which might, however improbably, issue in bargaining conditions—should be resisted at all costs.

The objections to regarding management as a profession are all of them subjective. They are fears, feelings, folk-ways, customary attitudes, prejudices in favour of, or against, this or that; and the best way to deal with a non-logical impulse or habit of thought which cannot be defended by argument—and any argument in favour of social distinctions is deeply out of sympathy with the spirit of the time—is to ignore it, to push it away below the threshold of consciousness. Yet, assuming that the word management is used of the activity normally understood by the word and confined strictly to executive functions, there seems to be no insuperable practical obstacle to the professional organization of those engaged in this occupation.

WELDING IN SHIP CONSTRUCTION

DURING the Second World War a large number of merchant ships were built in the United States, at a rate of production which could only have been achieved with the extensive use of welding. In the circumstances, it is not surprising that a proportion of these ships should have suffered structural failure when in service. It is now clear that most of the failures were examples of notch brittle fracture, such as has been experienced from time to time in many types of steel structure, both riveted and welded, on land and at sea, ever since iron and steel have been in common use. At the time, however, it was widely believed that the welded ships were intrinsically more prone to fracture than their riveted counterparts. With a different pattern of production, the British shipbuilding industry was not at that time faced with a similar problem. In spite of this, the Admiralty Ship Welding Committee was set up in 1943 with terms of reference, "To consider and investigate special problems arising from the employment of welding in ship's structures and to advise on methods for their solution". This Committee has just been disbanded, and its last report has been issued*.

Much of the work of the Committee was devoted to metallurgical studies relating to notch brittle fracture, and it is in this direction that the most radical changes have been proposed. Nevertheless, it was necessary to distinguish the differences in structural behaviour, if any should exist, between riveted and welded ships of otherwise identical design. The series of trials carried out for this purpose deserve wide recognition for their excellence of planning and execution. Four ships were chosen for the major trials. Of these, two were 12,000-ton tankers and two were 10,000-ton dry-cargo ships. The ships of each pair were identical, except for the alternatives of welded and riveted joints. In addition to the more obvious differences of design between the tankers and the dry-cargo ships, the former had a preponderance of shell framing in the longitudinal, and the latter in the transverse direction. Although the primary object of the tests was to compare the stress distributions to which the riveted and welded ships would be subjected at sea, it was decided that this could not be undertaken directly. Alternatively, on one only, the welded dry-cargo ship *Ocean Vulcan*, an extensive investigation was made, not only of the forces which North Atlantic sea conditions produced, but also of the stresses and deflexions which similar forces produced when applied in still water by means of ballast loadings. The latter were chosen to simulate various vertical and horizontal bending-moment conditions, shear forces and torsion moments. The still-water investigations were also carried out for each of the remaining ships.

* Admiralty Ship Welding Committee. Report No. R.6: Structural Tests in Still Water on Welded Dry Cargo Ship *Ocean Vulcan*. Pp. x+50+25 plates+109 diagrams+8 tables. 30*s*. net. Report No. R.7: Structural Tests in Still Water on Riveted Dry Cargo Ship *Clan Alpine*. Pp. x+18+16 plates+116 diagrams+9 tables. 30*s*. net. Report No. R.8: S.S. *Ocean Vulcan* Sea Trials—The Forces Acting on the Ship at Sea. Pp. viii+175+17 plates. 35*s*. net. Report No. R.9: *Ocean Vulcan* Sea Trials—Detailed Analysis of Record No. 1. E.3 (Loaded Condition). Pp. viii+17+87 diagrams. 25*s*. net. Report No. R.10: *Ocean Vulcan* Sea Trials—Detailed Analysis of Record No. 6. E.7 (Loaded Condition). Pp. viii+200 (187 pages of diagrams). 42*s*. net. Report No. R.11: S.S. *Ocean Vulcan* Sea Trials. Detailed Analysis of Record No. 6. W.5 (Ballast Condition). Pp. viii+12+124 diagrams. 27*s*. 6*d*. net. Report No. R.12: Structural Trials on S.S. *Ocean Vulcan* and S.S. *Clan Alpine*. Discussion of Results. (In the press.) (London: H.M. Stationery Office, 1953 and 1954.)

The confidence with which the results of such investigations may be accepted rests clearly on the independent checks which may be made on each set of readings. In this respect the investigators were particularly successful. In the static trials, close comparisons were possible between measured and calculated stress distributions at the test sections and between measured and calculated deflexions. In the sea trials similar successful comparisons were possible between stress distributions measured at a hull cross-section and those predicted from the forces estimated from water-pressure distributions on the submerged portion of the hull, together with hull acceleration measurements.

In general, none of the results does other than confirm the methods now adopted for calculating necessary hull structural strengths, and dispose of the possibility that any broad difference exists between the structural characteristics of otherwise similar welded and riveted hulls. Nevertheless, many differences of detail are exposed. It is shown, for example, that the shrinkages which take place when welds are deposited along plate edges give rise to initial buckles considerably greater than where riveting is employed, so that bending stresses are increased. Under these conditions, longitudinal framing is particularly effective, since the supporting members are disposed more favourably for the suppression of buckling due to longitudinal compressive loads. It is perhaps unfortunate that this is not stated among the conclusions, although the evidence is clearly given. On the other hand, one may wonder why so much space is devoted to proving that rivet slip is not important in contributing to the deformation under load of riveted hulls.

Some idea of the immensity of the task of computation from the measurements may be grasped by reference to the number of tables and diagrams in the various reports, and it is scarcely surprising that several years elapsed before publication was possible. It is fitting tribute to those concerned in the work that the results may now be so readily assimilated by the reader.

A. A. WELLS

NEW ZEALAND DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

REPORT FOR THE YEAR 1953–54

THE twenty-eighth annual report of the Department of Scientific and Industrial Research, New Zealand*, covers the year ended March 31, 1954. Besides the Minister's statement and the Secretary's report, it includes brief, but not technical, reports from the several branches of the Department and the incorporated research associations, and from the Cawthron Institute and the university colleges to which grants were made by the Department; to most of these latter reports a list of publications is appended. The new building for the Grasslands Division at Palmerston North, which is nearing completion, should largely meet the needs of this Division, and new accommodation has been provided at Lower Hutt for three research associations, while the Botany Division is now to be transferred from Wellington to a suitable building at Christchurch. In future, branches of the Department will publish periodic reviews of their work, giving more detail than was possible in those previously included in the Department's annual report: those in the present report merely list the principal projects under way.

The Secretary's report stresses the need for adequate and fireproof accommodation for the Botany Division and Geological Survey; but the additional land acquired at Owairaka should suffice for the needs of the Plant Diseases Division and the Fruit Research Station for many years to come. The Department's activities in oceanography have been reorganized, and increasing attention will be given to marine biology and geology and to studies of the temperature, salinity and movement of water masses in the New Zealand area. Net expenditure of the Department was £1,025,414, compared with £941,723 during 1952–53, and the staff at March 31, 1954, was 937, compared with 931 on April 1, 1953. Only six of forty-two vacancies for which provision was made in the estimates were filled during the year, and the professional staff was unchanged at 374; technical staff numbered 347. Of the total expenditure, 24·7 per cent was for services to other government departments and public bodies, 53 per cent for services (including research) to farming and industry, 9·5 per cent for grants to research associations, university colleges, etc., and 12·8 per cent for administration, information services, and publications. It is also estimated that about 47 per cent of the expenditure is on research and service to farming industries.

In view of the elimination of the technical reports from the various branches previously included, the Secretary's report gives a rather fuller general survey than previous reports. During the year the Soil Bureau published as a bulletin a "General Survey of the Soils of North Island, New Zealand", and preparatory work for the issue of a similar publication for South Island has commenced. A survey has also been commenced of the minor-element status of the major soil types in the Dominion, using sweet vernal grass, which grows throughout New Zealand, to indicate the soil nutrients available to it and thus eliminate the uncertainty of chemical methods of extraction of soils. The extensive investigation of bloat of dairy cows, which was commenced in 1952, indicates to date that bloat is caused by some soluble material or materials with foam-producing properties, and that a study of the physical condition of the rumen contents is the most promising line of investigation. A new strain of cocksfoot, based on plants of New Zealand origin, has now been produced and released under certification after trials which indicate an annual production 18–20 per cent higher than that of *C*23. The new strain has a wider seasonal range of production and begins growth earlier in the spring.

Trials carried out by the Plant Diseases Division in widely separated areas have shown that the establishment of red, white and subterranean clovers can be markedly improved by inoculating the seed with selected efficient strains of nodule bacteria, and an economic but effective method of applying the inoculum to commercial quantities of seed is being sought. The use of commercial insecticide–fertilizer mixtures for the control of grass-grub and *Oxycanus* in pastures by methods worked out by the Entomo-

* New Zealand. Department of Scientific and Industrial Research. Twenty-eighth Annual Report. Pp. 68. (Wellington: Government Printer, 1954.)

logical Research Station continues to increase: during 1952–53, 4,467 tons was used for this purpose compared with 2,109 during 1951–52, and production of DDT-superphosphate during 1953–54 is estimated at 6,200 tons. Of about 150 tons of DDT used in the Dominion, 107 tons is used to control these two pests alone, about 20 tons being used for orchard work and 20 tons for fly sprays and other purposes. In the Canterbury and Waikato areas alone, grass-grub attack on the 3·5 million acres of pasture is liable to cause an annual loss of £4 million. Attention is being given to particle size, wettability and the distribution of insecticide within a batch of fertilizer. The Entomological Research Station's investigation into the roles of *Eriococcus* and the associated fungus in relation to the death of manuka (*Leptospermum scoparium*) continued and also the mapping of the distribution of *Eriococcus*.

Tests of introduced varieties of linseed indicate that Marine, although not yielding as heavily as Golden Viking in a disease-free year, is a more reliable variety for New Zealand owing to its resistance to fungus (Pasmo) and to rust disease, except the rare and weak Race 12 of rust. Steps are being taken to reduce the great variation of type within strains and varieties of commercial vegetable seeds, especially among the Brassicas, by bulk seeding of selected plants, followed by progeny testing and further selection, and lines of savoy cabbage have been developed and characterized by increased percentage of marketable heads and uniformity of type and maturity. A comprehensive bulletin covering present knowledge of plant virus disease in New Zealand, and describing the control of cherry plum mosaic among cuttings grown as stocks, which has been achieved by removing infected plants, was published during the year.

Considerable progress was made by the Animal Ecology Section during the year with its analysis of data on reproduction and parasites of rabbits and with other rabbit population studies.

The Geophysics Division is conducting a gravity survey which will provide information on the depth of volcanic debris overlaying the basement greywacke and also more detailed surveys of the Waiotapu area, using seismic and gravity methods to elucidate the geological structure, and magnetic and electrical methods to delineate the high-temperature conditions near the surface. These surveys will provide the data required for the development of power from geothermal steam, and the Dominion Laboratory has continued and extended observations of the temperature and discharge of hot springs, the periods of geysers, etc. Officers from this Laboratory and the Dominion Physical Laboratory have developed the technique of radiocarbon dating of carbonaceous materials for use in New Zealand, and a number of the ash showers blanketing a large part of the centre of the North Island have already been dated.

In the Dominion Laboratory a small team has developed a process of drying meat in slices up to half an inch thick, in which the slices of frozen meat are submerged in melted fat at 140–160° F. (60–71·1° C.) and the moisture extracted under vacuum. Satisfactory material has been obtained from both beef and mutton in pilot-plant trials and were tested by Sir Edmund Hillary on his recent Himalayan expedition. Flour testing and reporting procedures at the Wheat Research Institute have been improved, and experimental studies of baking processes continued. Large reserves of coal in the Maramarua area for possible steam–electric generation were proved by the Geological Survey in co-operation with the Mines Department. The Department is now responsible for the annual preparation of charts showing the magnetic variation of the compass for an extensive area of the south-west Pacific, and the shipping companies and Royal New Zealand Navy are co-operating in a programme to determine the chart error at about thirty selected points. Large-scale tests of promising pozzolanic materials for constructional purposes have been made at the Dominion Physical Laboratory. Some eighty per cent of the original recommended range of standards equipment has now been received, including a Diesselhorst thermo-electric free potentiometer for temperature measurement and the first of a range of precision balances for calibrating weights, and an electron microscope which is in constant use. Full-scale field trials by the Extension Division of the Department of Agriculture indicate that the process for the production of fused calcium–magnesium phosphate from New Zealand olivine rocks, developed by the Chemical Engineering Section of the Dominion Laboratory, is technically feasible.

POLITICAL SCIENCE AS A UNIVERSITY SUBJECT

A REPORT on "The University Teaching of Social Sciences: Political Science"* has been prepared by Prof. William A. Robson on behalf of the International Political Science Association and published by the United Nations Educational, Scientific and Cultural Organization. Political science, writes Prof. Robson, "is, no doubt, the master science which can do most to assuage the maladies and struggles and conflicts of man in society"; this is so, he argues, because "political science is concerned with the study of power in society"—a "fundamental concept" which "integrates all the various branches of the subject". Having regard, then, to the troubles of the world in which we live and the "burning practical importance" of political science, it might be expected that a large measure of attention would be paid both to teaching and to research in the subject; but the interesting and painstaking survey of developments in this field which Prof. Robson has carried out shows that this is far from the fact. His assumptions about the nature of political science being what they are, this leaves him with an interesting problem to solve.

What Prof. Robson has to say is illuminating, but somewhat pessimistic. Political science exists as an under-developed territory, or backward area, within the universities of the Western world because it has never cut itself adrift from other subjects, such as law, economics and philosophy. It is treated as a somewhat unwanted step-child, whereas, he asserts, it should be accepted as "a separate and clearly distinguished discipline" to which the same status should be accorded as any other of the basic subjects that form part of the university curriculum of a liberal education. It is simply because those who have been responsible for making university and public policy have failed to recognize the importance of teaching and research in political science, Prof.

* The University Teaching of Social Sciences: Political Science. By W. A. Robson. Pp. 252. (Paris: Unesco; London: H.M.S.O., 1954.) 1.50 dollars; 8*s.* 6*d.*; 400 French francs.

Robson suggests, that the present somewhat lamentable state of affairs has arisen.

On the other hand, it may be asked what have political scientists done to establish themselves in the influential position which Prof. Robson has marked out for them. Is theirs, in fact, a 'master science'? Here Prof. Robson injects into the discussion some very wise remarks, which place the problem of the under-development of political science in a somewhat different setting. It is evident to him that, in the light of our present knowledge, it is beyond the power of political science "to formulate general laws which associate in a precise manner particular causes with specified effects". The political scientist is, indeed, "dealing with a realm of thought and action about which men and women hold the most profound differences of opinion and belief". His methods are imprecise, and his work is apt to be influenced too directly by the winds of passion. If this is accepted as the truth, where, it must be asked, do political scientists stand in relation to the other social and natural sciences?

The bold claim that political science can exist as a 'master science' must indeed be relinquished in favour of something more humble. The solving of such problems as the 'cold war', the international control of atomic energy, race relations in Africa, the stimulation of "genuine citizen participation in government", and the protection of the world against "stiff-necked bureaucracies incompatible with democracy", which Prof. Robson regards as the concern of the political scientist, is a task that will require the collaboration of all social scientists—supposing that they do not prove to be too much for the wit of man altogether. If political science is to flourish it must, in present circumstances, accept more help from the other social sciences than it contributes to them.

We thus find ourselves in the position of seeking the foundations of a political science that can be taught as part of a liberal education. It may be suggested that it is because this has not been done with sufficient intellectual courage that the subject has failed to expand with the rapidity that the necessities of our times would appear to demand. The solving of the political problems that are so essentially bound up with the acquisition and exercise of power within any society can only be achieved on an empirical basis; it is only in this way that we shall be able to lay the foundations of a subject of study which can be called truly scientific.

In Great Britain we are in an especially favourable position to attempt this, because our tradition in political science has always been empirical or practical as well as philosophical or theoretical. We have never taken a sentimental or idealized view of the personalities or behaviour of our rulers. As William Pitt remarked at the end of the eighteenth century, "unlimited power is apt to corrupt the minds of those who possess it", and we have acted accordingly. It was in Prof. Robson's own London School of Economics that Graham Wallas made such strenuous efforts to apply practical wisdom of this kind to the conditions of his own day, and it is for the contemporary political scientist, in collaboration with sociologists, anthropologists and psychologists, to work out a theory dealing with the use of political power which can be applied both to problems of government and administration, on one hand, and to those of the individual politician, administrator and citizen on the other.

T. S. Simey

EFFECTS OF RADIATION AND OTHER DELETERIOUS AGENTS ON EMBRYONIC DEVELOPMENT

THE Biology Division of the United States Atomic Energy Commission sponsored a symposium on the effects of radiation and other deleterious agents on embryonic development, which was held on April 20, 1953, at the Oak Ridge National Laboratory, Tennessee. The proceedings have been published as a supplement to the *Journal of Cellular and Comparative Physiology* (**43**, Supp. 1, May 1954. Pp. 337+6 plates; from the Wistar Institute of Anatomy and Biology, Philadelphia; n.p.). This symposium volume contains eleven full-length papers and some short but valuable summarizing remarks by Dr. Paul Weiss. Each of the papers is followed by a discussion by the author and members of an obviously interested and critical audience.

Four of the papers deal with the effects of ionizing radiations on developing embryos of the rat, an amphibian and the mouse; and one may perhaps add to this group a study on the outcome of pregnancy in women exposed to the atomic bomb blast in Nagasaki. Experimental papers in this group have been mainly concerned to plot out the different types of radiation damage which follow exposure to irradiation at different times of embryonic development. The facts which are revealed are interesting and probably of considerable technological importance in a world in which ionizing radiation seems likely to become one of the normal hazards not only of war but also of peaceful industry. The interpretation which should be put on them still remains rather obscure. Much of the discussion is in terms of critical periods; but, as Weiss points out, one is not justified in assuming that the crucial activities which bring about the final visible effects are produced at the actual time at which the irradiation is given, a situation which makes the identification of the critical periods by no means easy. Moreover, the evidence suggests that radiation may produce many different types of damage, not only on the chromosomes but also on the cytoplasm.

One might hope, perhaps, to have rather more understanding of the kind of damage produced by certain chemical substances such as the nitrogen mustards, the vitamins, cortisone, etc. There are five papers dealing with such topics. Again, the reader is confronted with a large amount of actual information, the explanation of which remains for the most part still to seek. Perhaps the most interesting of this group of papers is a further report by Landauer of the recent progress of his massive and thorough study of the production of phenocopies by chemical means in chick embryos. In general, however, one gets the impression that our understanding of embryonic development would be better advanced by studies which employ agents the activities of which are more precisely understood than those of irradiation or toxic substances such as the mustards (for example, specific enzyme poisons or metabolic analogues); while for the interpretation of the embryonic effects of these 'blunderbuss' deleterious agents one will probably have to wait until studies on simpler systems have revealed more precisely the nature of the effects which they produce.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Chromosomes of Monkeys and Men

Chromosome numbers have been recorded in very few species of primates. All observations have been on the male, the heterozygous sex. The following are the more serious references :

Old World Primates			
Homo sapiens	European and Negro	48	Painter[1], Koller[2], La Cour[3], Hsu[4].
	Japanese	47	Oguma[5].
Pan calvus	Chimpanzee	*c.* 48	Yeager *et al.*[6]
Macacus mulatta	Rhesus macaque	48	Painter[7]
New World Monkey			
Cebus sp.	Capuchin monkey	54	Painter[7].

Recent developments of technique, however, enable us to count the numbers and describe the forms of mammalian chromosomes with the same ease and accuracy as has long been possible for grasshoppers and newts. We have therefore examined all the species of primates available to us. The following are our counts (Figs. 1–4) :

Homo sapiens	
European, bone marrow (Fig. 1)	48
Indian, testis	
Papio papio, Guinea baboon, testis (Fig. 2)	42
Macacus nemestrina, pigtailed monkey, testis (Fig. 3)	
Macacus mulatta, Rhesus macaque, testis (Fig. 4)	

The chromosomes of man and monkeys are generally not unlike. In the spermatogonia illustrated they are, of course, more contracted than in the premyelocytes of the bone marrow. With regard to the individual chromosomes we agree with Koller (who has studied meiosis), and with La Cour and Hsu, that in man *X* is a medium-sized chromosome and *Y* one of the smallest, although not individually recognizable at mitosis.

The three species of monkey are alike in two respects in which they differ from man. First, they lack the pair with median centromeres which is the largest pair in the human complement. Secondly, they have a *Y* chromosome which is much smaller than the human *Y*. It is also much smaller than any other chromosome in their own complements and is therefore at once and always recognizable at mitosis (Figs. 2–4).

Since almost the whole of the *Y* in man can be accounted a pairing segment exchangeable between *X* and *Y*, all three monkeys must have a much shorter length of *X*–*Y* exchangeable genes than man. The difference between man and monkey should show at meiosis, of which an account will be published later. The similarity between the monkeys, on the other hand, should be seen in their capacity for hybridization. A cross has in fact been made between *Papio sphinx* ♀ and *Macacus mulatta* ♂, and offspring have been raised in captivity.

These observations indicate that, apart from Painter's study of man, the earlier accounts based on sectioned material are not to be relied upon. They especially lead us to reject Oguma's claim of an unpaired *X* chromosome in the human male. The *Y* chromosome is obvious and characteristic in all our four species as it has been in all other mammals studied. Its absence, which would require an innovation in the centromere of the unpaired *X*, has never been established in any vertebrate.

Finally, our observations show, what has not so far been clear, that chromosome form and number are unstable in the primates. Both sex chromosomes and autosomes can be used to test relationships of

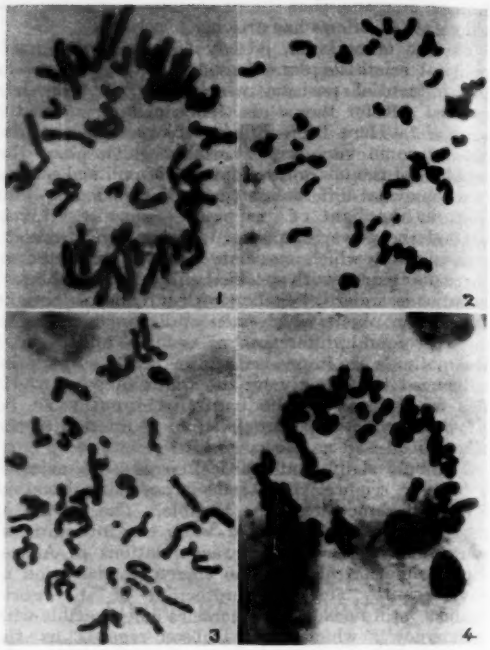

Fig. 1. Bone marrow, pre-myelocyte, man (× *c.* 2,140)
Figs. 2–4. Spermatogonium of monkeys. (Fig. 2, × 1,844 ; Figs. 3 and 4, × *c.* 2,140)
All acetic alcohol Feulgen squashes. Note : the small *Y* chromosome is at 5 o'clock in Fig. 2 ; central in Fig. 3 ; and at 7 o'clock in Fig. 4

descent. With this regard we should like to repeat the opinion[8] that the chromosomes of the great apes should be studied before these species die out altogether. In order to facilitate this we must mention that our technique is a slight modification of that described by Sachs[9,10]. Anyone who is able to obtain fresh monkey testis material should fix it in fresh 1 : 3 acetic alcohol and keep it, after twelve hours, at 0° C. Feulgen squash preparations should, however, be made as soon as possible (after twelve hours). Fixations may be sent by airmail to Dr. A. Haque, Botany Department, University of Dacca, East Pakistan.

We wish to thank the following for material and for their very kind help : Prof. S. Zuckerman, Dr. A. P. D. Thomson and Dr. P. Eckstein, of the Birmingham School of Medicine, for the baboon and macaque ; Prof. E. G. T. Liddell, Dr. P. Glees and Dr. J. Cole, of the Oxford Department of Physiology, for the pigtailed monkey ; and Dr. M. A. Nomani, of King Edward Hospital, Benares, India, for the human testis fixation.

C. D. Darlington
Ashraful Haque

Botany Department,
University of Oxford. Dec. 1.

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Delayed Toxicity of Radiostrontium in Monkeys

In a long-term experiment on the effects of low doses of radiostrontium, six monkeys have died following single injections of pure 'carrier-free' strontium-90 of less than 0·2 mc./kgm. body-weight. The hæmatological findings, and the comparison of survival-times with those obtained in animals which received higher doses[1], are noteworthy.

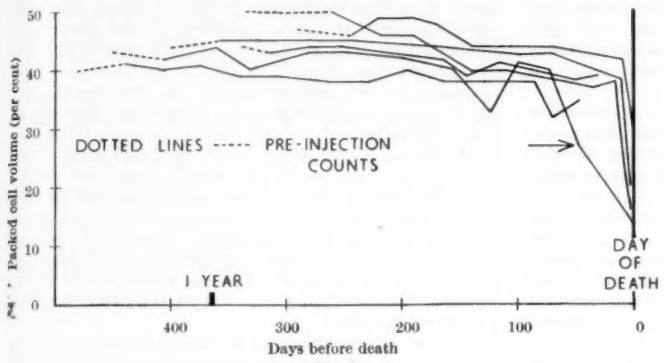

Fig. 1

The blood picture in the six animals did not seriously deteriorate following the injections until a sharp terminal fall shortly before death, as shown in the graph of packed cell volume (Fig. 1). In four of the animals, the hæmatological findings were within normal limits until two or three weeks before death, and in only one case was there any significant gradual decrease in red blood cell count and packed cell volume before the terminal drop. Only in one animal (marked → on Fig. 1) was a severe drop in white blood cells observed; the count fell from 13,000/mm.³ 46 days before death, to 1,200/mm.³ at death. The animals appeared in normal health until about a week before death.

In the three animals which were examined histologically, the most severe lesions were seen, as expected, in bone marrow, reproductive organs, and reticulo-endothelial system. Damage in the latter varied widely in the different animals. In one animal the spleen exhibited extreme atrophy, whereas in another the germinal centres were large and prominent with numerous mitotic figures present.

It is notable that the times of survival for the six monkeys fit the straight-line extrapolation of the graph of survival times for the thirteen 'high-dose' monkeys (Fig. 2).

All the monkeys were kept on a good mixed diet of medium calcium content, and the radiostrontium content of their fæces and urine was assayed. The logarithm of daily excretion was plotted against the logarithm of time T (days) after injection, and from the straight line for the whole period the relationship

$$E \text{ per cent} = 10\,T^{-1\cdot0}$$

was deduced for the daily excretion, E per cent, of the injection dose. The carcass at death contained an average of 30 per cent of the injection dose.

The investigation is continuing, and we intend to report elsewhere on the details of histopathology, hæmatology and radioactivity assays. Observations to date on the twelve surviving monkeys do not conflict with these preliminary findings.

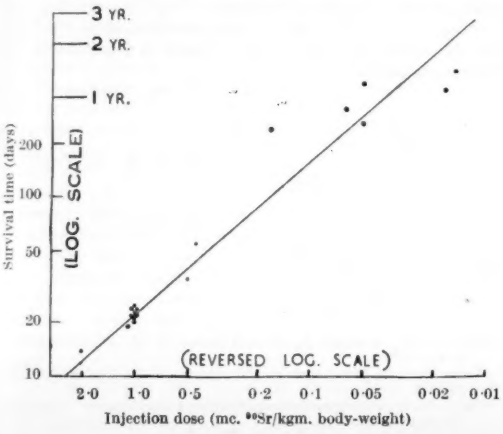

Fig. 2

Acknowledgments are due to Mr. A. H. Booth and the College authorities, and to the Medical Research Council.

G. M. Edington*
J. M. Judd†
A. H. Ward
University College of the Gold Coast,
Achimota. Oct. 18.

* Of the Medical Research Institute, Korle Bu, Gold Coast.
† Now with Department of Tsetse Control, Gold Coast.

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Action of Ionizing Radiations on Catalase in Presence of Cysteine, Cystine and Glutathione

Forssberg[1] reported that cysteine and glutathione did not protect catalase against inactivation by X-rays, but on the contrary increased the radiation effect on the enzyme. Most organic substances act as protectors when added as a second solute to the solution of the primary solute. Since cysteine and glutathione have been used in protection experiments *in vivo*[2,3] and *in vitro*[4,5] it was decided to re-investigate the inactivation of catalase by irradiation, in view of the apparently exceptional nature of the effect of these substances.

Two types of radiation have been used: γ-rays from cobalt-60, and high-energy electrons from a linear electron accelerator. Beef liver catalase was irradiated alone and in the presence of cysteine, cystine and glutathione (—SH), and the resultant effects on the enzymatic activity, electrophoretic and chromatographic behaviour and on the ultra-violet absorption were examined.

Doses up to 93×10^4 ergs/gm. were used, and the catalase concentration varied from $2{\cdot}25 \times 10^{-4}$ gm./ml. to $4{\cdot}45 \times 10^{-3}$ gm./ml. Irradiation was carried out in air, oxygen and nitrogen at pH 7·4.

(*a*) Catalase activity was measured by the method of Bonnichsen, Chance and Theorell[6]. All three substances depressed catalase activity *per se*, but protected the enzyme against radiation. At low radiation doses failure to take account of this depressing effect can lead to the apparent result of an increase of the radiation effect.

(*b*) Paper electrophoresis of unirradiated catalase showed a single spot, whereas irradiated catalase gave a comet-shaped streak. When irradiation took place in the presence of cysteine or glutathione, the subsequent electrophoretic pattern was the same as that of the unirradiated solution; that is, one spot appeared in the same position as unirradiated catalase. Protection occurred with cystine too, although to a lesser degree due to its low solubility.

(*c*) The chromatographic behaviour of catalase changed markedly after irradiation. This change did not occur when cysteine or glutathione was present during irradiation, and was not so pronounced when cystine was used.

(*d*) Catalase shows two maxima in the ultra-violet, at 275 mμ and 405 mμ. In the present instance, $D_{405}/D_{275} = 0{\cdot}685$. After irradiation the absorption increased at 275 mμ and decreased at 405 mμ, so that $D_{405}/D_{275} = 0{\cdot}226$. When cysteine or glutathione was present during irradiation, the absorption did not change.

Thus catalase is protected against γ-rays and high-energy electrons by cysteine, cystine and glutathione. It is noteworthy that the oxidized form of cysteine, namely, cystine, is nevertheless able to compete for the radicals produced by radiation.

This work will be reported in detail elsewhere.

W. M. Dale
C. Russell

Department of Biochemistry,
Christie Hospital and Holt Radium Institute,
Manchester 20. Sept. 17.

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Radiation Dosimetry of Rubidium-86

Interest has recently arisen in the possibility of using rubidium-86 as a tracer for potassium in biological studies where the short half-life of potassium-42 presents difficulties[1]. In order that an assessment may be made of the radiation dosage arising from the use of this isotope, the γ-ray output and mean β-ray energy have been measured. Rubidium-86 decays with the emission of a 1·80 MeV. β-ray or by a 0·72 MeV. β-ray followed by a 1·08 MeV. γ-ray[2]. The results reported here indicate that the γ-ray occurs in about 8·4 per cent of disintegrations.

The material produced by neutron irradiation of the purest rubidium chloride at present available contains considerable activity from cæsium-134. A sample of the irradiated material was therefore purified by seven recrystallizations of the acid tartrate, after which only about 0·05 per cent of the disintegrations were due to cæsium-134 (as judged by the subsequent increase in the ratio of γ- to β-ray activity over a period of three months). The disintegration-rate of an aliquot of this material was determined by 4π-ray counting, a method which has been found satisfactory for emitters of relatively high-energy β-rays[3].

The γ-ray dose-rate was measured by comparison against a radium standard, using a graphite ionization chamber, and assuming that 1 mgm. of radium screened by 0·5 mm. of platinum gives 8·3 r./hr. at 1 cm. The emission of β-ray energy was measured by the method of Gray[4], in which the ionization produced in a chamber lined with agar containing a known concentration of the active material is compared with the ionization produced by a standard radium source at known distance. The ionization measurement was related to energy absorption on the assumption that 32·5 eV. is required for the formation of an ion-pair in air. It was found that the average energy emitted as β-rays per disintegration of rubidium-86 is 0·66 MeV., and that the γ-ray dose-rate at 1 cm. from 1 mc. is 0·525 r./hr. An appreciable fraction of the γ-ray effect is due to bremsstrahlung. Since these radiations fall largely in a region where the sensitivity of the chamber changes rapidly with quantum energy, it is not possible to calculate the contribution, but its magnitude can be inferred from the figure 0·025 r./hr. at 1 cm. obtained from 1 mc. of phosphorus-32 under similar conditions.

In view of the closeness of the maximum energies of the β-rays of these two isotopes, it is reasonable to assume that the bremsstrahlung effect is proportional to the square of the maximum energy, when, allowing for the presence of the low-energy branch, the bremsstrahlung of rubidium-86 would give 0·027 r./hr. mc. at 1 cm. The 1·08 MeV. γ-ray therefore gives 0·50 r./hr. per mc. at 1 cm., a figure which leads to the conclusion that the γ-ray is emitted in only 8·4 per cent of disintegrations. Accepting this figure for the branching ratio, and allowing for the forbidden shape of the β-ray spectrum[5], the calculated value of the mean β-ray energy is 0·70 MeV. The discrepancy between this figure and the experimental results is scarcely greater than the uncertainty of the value assumed for the energy of formation of an ion-pair.

A regression line calculated from seventeen observations over a period of 79 days gave a figure of $18{\cdot}74 \pm 0{\cdot}026$ days for the radioactive half-life of a sample of rubidium-86. This reduces to 18·66 days when allowance is made for the 0·05 per cent cæsium-134 initially present.

We are indebted to the Medical Research Council for the loan of the equipment used in the ionization measurements.

E. W. Emery

Department of Medicine,
University, Manchester.

J. E. S. Bradley

Postgraduate Medical School,
London, W.12.

N. Veall

Physics Department,
Guy's Hospital Medical School,
London, S.E.1.
Nov. 1.

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Removal of Background in β-Sensitive Nuclear Emulsions

We have tried to reproduce the procedure recommended by H. Faraggi[1] and G. Albouy[2] for removing the background on Ilford *G5* plates before experimental exposure. The treatment consists in suspending the plates for a certain time in water vapour of a given temperature. After we had made a number of unsuccessful attempts following the methods of other investigators[3], it occurred to us that the small chlorine content of Paris water might be responsible for the difference in the results. We tried water containing 12 mgm. chlorine per litre for the production of the water vapour, and found that we could remove the background at 60° C. in five hours (instead of twenty hours required by the French investigators) without affecting the sensitivity of the plates to subsequent β-rays if the plates were dried after the treatment. α-Tracks withstood this treatment. These results seem to throw some light on the process involved.

Details and further experiments under varying conditions will be published in the *Proceedings of the Vienna Academy of Sciences (Wien Ber.)*.

T. Matitsch
Ch. Matiasek
B. Karlik

Institut für Radiumforschung der
Akademie der Wissenschaften,
Vienna.
Sept. 14.

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Interaction of Two Constituents in Ferromagnetic Materials showing Reverse Thermo-remanent Magnetism

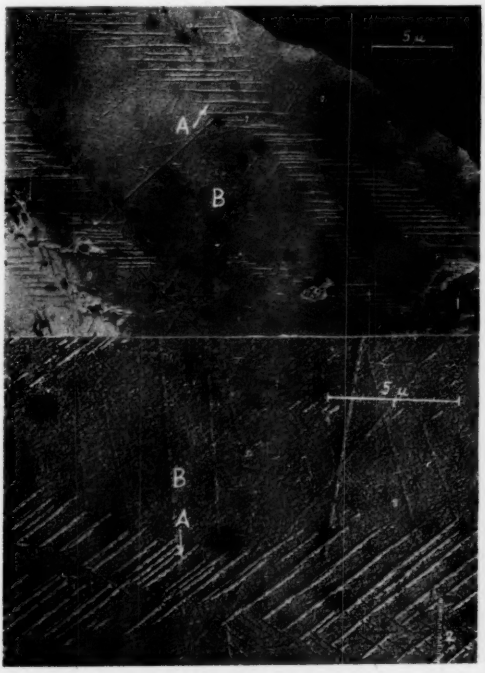
In three earlier communications[1], we described the magnetic, chemical and crystallographic properties of the ferromagnetic minerals causing self-reversal of thermo-remanent magnetization of igneous rocks. The results of studies of these properties showed that most grains of ferromagnetic minerals in the Haruna dacitic rocks consist of two different ferromagnetic constituents; one called *A* is titanium-poor titanomagnetite having a crystal structure of inverse spinel type and Curie point around 500° C.; another called *B* is a solid solution of ilmenite and hæmatite (hæmoilmenite) having rhombohedral crystal structure and Curie point of about 230° C.

All the magnetic experiments showed that the reversed thermo-remanent magnetism of these minerals and their mother rock is due to the effect of close interaction of these two different ferromagnetic constituents during the process of their cooling in a magnetic field. This is in full agreement with Néel's[2] two-constituent theory of reverse thermo-remanent magnetism. But it was not clear how these constituents interact with each other in actual mineral grains.

It was found, on the other hand, that a simple mixture of these two constituents does not show reversed thermo-remanent magnetism even when the mixture is tightly compressed. Therefore, it may be presumed that the relationship of these constituents to each other is a form of intergrowth of one into another, thus resulting in a very close interaction between them.

Figs. 1 and 2 show electron-microscope photographs of etched surfaces of ferromagnetic minerals in the Haruna rock. The polished surfaces of the minerals were etched by hydrochloric acid for 15 min.; parts of constituent *A* (being approximately magnetite) can easily be etched, but parts of constituent *B* are scarcely affected. The original photographs have magnifications of 4,900 (for Fig. 1) and 8,000 (for Fig. 2). It is clearly shown in these figures that constituent *A* intergrows in echelon into constituent *B*. The width of strips of constituent *A* is approximately 0·2 μ. The length of the strips ranges apparently from 1 μ to 5 μ in the photographs; but it seems likely that these strips are more or less linked one to another along specified directions forming fairly long strips of narrow width.

Judging from the above-mentioned scale of strips of constituent *A*, we may presume that each strip consists of a single domain or several domains. In other words, the magnetization of these strips may be of the same order as the spontaneous magnetization of constituent *A*. Then the magnetic field caused by the strong magnetization of strips of constituent *A* in the neighbouring strips (of mean width 0·5 μ) of constituent *B* will be, on the average, opposite to the direction of magnetization of the strips of *A*, which must be parallel to that of the external magnetic force. The detailed calculations cannot be reproduced here, but it can be shown that the magnetic interaction between strips of constituents *A* and *B* mentioned above can result in reverse thermo-remanent magnetization.



Intergrowth of constituent *A* in echelon into constituent *B* in a Haruna ferromagnetic mineral

Table 1. Crystal Structure and Curie Point of Constituents *A* and *B* in Dacites at Haruna, Asio and Towada, Japan

Locality	Constituent	Crystal structure	Lattice parameter	Curie point
Haruna	*A*	Cubic	$a_c = 8{\cdot}403 \pm 0{\cdot}002$ A.	460° C.
	B	Rhombohedral	$a_{rh} = 5{\cdot}480 \pm 0{\cdot}002$ A. $\alpha_{rh} = 55° 08' \pm 01'$	230° C.
Asio	*A*	Cubic	$a_c = 8{\cdot}397 \pm 0{\cdot}004$ A.	460° C.
	B	Rhombohedral	$a_{rh} = 5{\cdot}483 \pm 0{\cdot}004$ A. $\alpha_{rh} = 55° 01' \pm 03'$	230° C.
Towada	*A*	Cubic	$a_c = 8{\cdot}412 \pm 0{\cdot}003$ A.	390° C.
	B	Rhombohedral	$a_{rh} = 5{\cdot}491 \pm 0{\cdot}001$ A. $\alpha_{rh} = 54° 59' \pm 01'$	100° C.

Thus, it seems that the mechanism of producing the reverse thermo-remanent magnetism in the Haruna ferromagnetic minerals is established. It is also true, however, that the presence of these two different constituents, *A* and *B*, in rocks does not always result in the self-reversal of thermo-remanent magnetism. As shown in Table 1, ferromagnetic minerals of dacites at Haruna, Asio and Towada in Japan are composed of similar constituents, their magnetic properties closely resembling each other. The total thermo-remanent magnetism of the Haruna rocks is reverse, but the total thermo-remanent magnetism of the majority of the Asio rocks is normal at the atmospheric temperature, though there is a distinct tendency towards reversed magnetization of constituent *B* in the latter. In the Towada rocks, the total thermo-remanent magnetization is perfectly normal, the direction of constituent *B* being parallel to that of constituent *A*. The magnetic interaction between *A* and *B* is strongest in the Haruna rocks and the weakest in the Towada rocks, where it is practically negligible. Thus it may be concluded that the self-reversal of thermo-remanent magnetization owing to the two-constituent mechanism can take place in rocks only under the particular condition that ferromagnetic minerals consist of the *A*- and *B*-constituents, and further that they are closely coupled as regards scale of domain, as illustrated, for example, in Figs. 1 and 2.

Thanks are due to Prof. J. Bartels and other members of the Geophysikalisches Institut, Göttingen, for their help in preparing this communication and for discussions.

T. Nagata
S. Uyeda

Geophysical Institute,
Tokyo University.
Oct. 13.

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An Attempt to observe Whistling Atmospherics near the Magnetic Equator

The 'whistling atmospheric', or 'whistler', is the most common of the several types of quasi-musical atmospheric that are observed in the audio-frequency band of the radio spectrum. It takes the form of a whistling tone that falls steadily in pitch, appearing at about 10 kc./s. and falling to about 1 kc./s. in the space of 1–4 sec. A recently published study of these atmospherics[1], based on observations made at the Cavendish Laboratory, Cambridge, during 1950–51, gives support to the theory of Barkhausen[2] and Eckersley[3], which supposes them to be produced by dispersion in the ionosphere of the impulsive atmospheric 'clicks' radiated by lightning strokes. The whistlers are thought to travel through the ionosphere in the extraordinary (right-hand circularly polarized) magneto-ionic mode of propagation, in which mode, at frequencies below the gyro-frequency, the waves are able to penetrate the lower ionosphere without suffering total reflexion. For the details of this theory reference should be made to the sources cited; here it is sufficient to state that the characteristics of the extraordinary mode are found to be strongly influenced by the earth's magnetic field, and the resulting anisotropy is such that the ray paths of the whistlers through the ionosphere must follow the lines of force. It is evidently a consequence of the theory that the occurrence and properties of the whistlers should depend on the magnetic latitude of the point of observation, and in particular that they should not occur near the magnetic equator, where the lines of force are horizontal and the waves, therefore, unable to travel up through the lower ionosphere to the less absorbing regions above.

In order to test this prediction, one of us (J. R. K.) has carried out a series of observations in the audio-frequency band at Achimota, Gold Coast (lat. 6° N., long. 0° 12′ W.), which is about 10° north of the geomagnetic equator. The atmospherics were received on the equipment that was previously used in the experiments at Cambridge. The work extended over about three years, from December 1951 to March 1954, and consisted in all of seventy listening periods averaging about 15 min. each. Listening was done at varying times of day and night, but especially in the late afternoon and evening, which had proved to be favourable times of day for whistlers in the Cambridge records. Nevertheless, at no time during the whole series were any whistlers detected, though the usual varieties of impulsive atmospheric[4] were plentiful. As frequent checks were made of the gain-level and correct functioning of the receiver, it is unlikely that any whistlers could have occurred during the listening periods and escaped notice.

At middle latitudes whistlers are quite common, and their rate of occurrence is largely independent of time of year[4]. In the Cambridge observations the mean rate for all hours was 1·3 per min., while the figure for 1730 G.M.T., when activity tended to be highest, was 3·1 per min. During November 1952–April 1954, some records of audio-frequency atmospherics at Chelmsford, England, were taken at intervals by Isted, in connexion with some studies of very high-frequency scatter phenomena[5], and while no systematic counts of whistlers were made, it was noted that they were maintaining their normal activity (private communication). Thus it is known that during much of the period covered by our observations whistlers were in evidence at middle latitudes, and probable that this was the case during the remainder. It therefore appears that the failure to observe them at Achimota was due to a genuine effect of magnetic latitude, in agreement with the theoretical predictions.

Acknowledgment is made to Prof. H. E. Huntley and the staff of the Physics Department of the University College of the Gold Coast for facilities and assistance in connexion with this work. We are most grateful to Mr. G. A. Isted, of the Marconi Wireless Telegraph Company, Ltd., for allowing us

to make use of his unpublished results. One of us (L. R. O. S.) is indebted to the Chief Scientist, Ministry of Supply, for permission to contribute to this communication.

J. R. Koster

Physics Department,
University College of the Gold Coast,
Achimota, Gold Coast.

L. R. O. Storey

Radar Research Establishment,
(Ministry of Supply),
Malvern, Worcs.

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Change of Elastic Constants in a Superconductor

It is known[1] that there must be a small difference between the elastic constants of a superconductor in the superconducting and the normal states. The difference expected is of the order of 1 part in 10^5, but no actual measurement has so far been reported. We have now used a statical method to measure the change in the modulus of rigidity of a chemically pure polycrystalline tin wire when superconductivity is destroyed by a longitudinal magnetic field.

The specimen was placed vertically in liquid helium, and fixed at the lower end. The upper end was connected by a rigid rod to a phosphor bronze wire at room temperature. A twist applied to the top of the bronze wire then distributed itself between the two wires according to their torsional constants. This equilibrium distribution of strain changed on destruction of superconductivity, and the change was observed by means of an optical lever, as described by Jones[2]. Too much torsion of the tin caused excessive creep, so that the deflexion changes actually measured were less than 5×10^{-7} radians.

The results of several runs are plotted in Fig. 1 in the form $(G_n - G_s)/G_n$, where G_n and G_s are the rigidities in the normal and superconducting states respectively.

Absolute calibrations are only available for some of the runs. Results for the uncalibrated runs have been normalized to fit the calibrated runs at 2° K., and they are thus of help in establishing the dependence of the effect on temperature. The full curve represents the function $A\{1 - (T/T_c)^4\}$, where T_c is the transition temperature, and the constant A has been chosen for agreement with the observations at 2° K. It can be deduced from work on the change of critical field of tin with stress[3] that the difference in volume between the superconducting and normal states may be expected to be dependent on temperature in this way. This is also in agreement with the work of Lasarew and Sudovstov[4]. It can easily be shown that, in any event for a lattice with central forces, the difference in the shear moduli of the two states will depend on temperature in the same way as the volume difference.

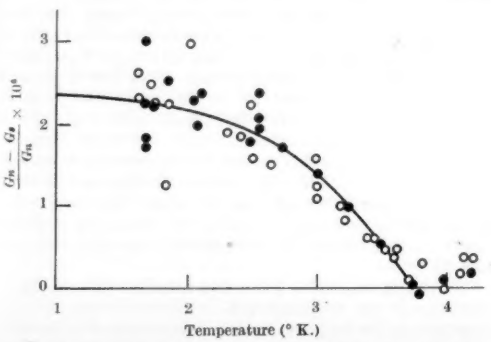

Fig. 1. Temperature variation of $(G_n - G_s)/G_n$ for tin. ●, Runs with direct calibration; ○, uncalibrated runs normalized to fit at 2° K. The full curve represents the function $A\{1 - (T/T_c)^4\}$ with A chosen to fit the results at 2° K.

I am grateful to Prof. P. Grassmann, in whose Institute this work was done, for his interest and encouragement.

J. L. Olsen

Institut für Kalorische Apparate und Kältetechnik,
Eidgenössische Technische Hochschule,
Zürich.
Nov. 8.

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A Phase Diagram for 1 per cent Carbon–Iron Alloys containing up to 16 per cent Nickel

During the course of an investigation into the austenite stabilization phenomena of iron–nickel alloys containing 1 per cent carbon, it became necessary to obtain some knowledge of the limiting solubility of the carbide in the austenite. There appeared to be no specific information available concerning the phase relationships of such alloys and, due to the promotion of graphitization by high nickel contents[1], a great deal of uncertainty attends the nature of the iron–carbon–nickel ternary system.

Casts weighing 18 lb. were made in a high-frequency furnace; the ingots, the analyses of which are given in Table 1, were forged to $\frac{5}{16}$-in. diameter rods which were normalized from 1,050° C. Specimens were machined, nickel-plated and tempered for 24 hr. at 600° C. before testing. The progress of transformation was followed dilatometrically, using a dilatometer previously described[2], and temperatures measured by means of platinum/platinum–rhodium thermocouples peened centrally into the specimens. Readings were taken at 5 deg. C. intervals with a heating-rate of 1 deg. C. per min.

The results, presented in Fig. 1, agree very well with the 1 per cent carbon section which may be

Table 1. Principal Alloying Elements of the Nickel Steels Examined

No.	% C	% Ni	% Si	% Mn
1	1·02	0·03	0·23	0·32
2	1·04	0·66	0·19	0·36
3	0·98	1·03	0·13	0·39
4	1·02	2·01	0·15	0·31
5	1·02	3·06	0·21	0·34
6	1·00	4·09	0·13	0·32
7	1·00	5·06	0·26	0·25
8	0·93	7·10	0·30	0·19
9	1·04	9·9	0·22	0·26
10	0·99	15·8	0·47	0·42

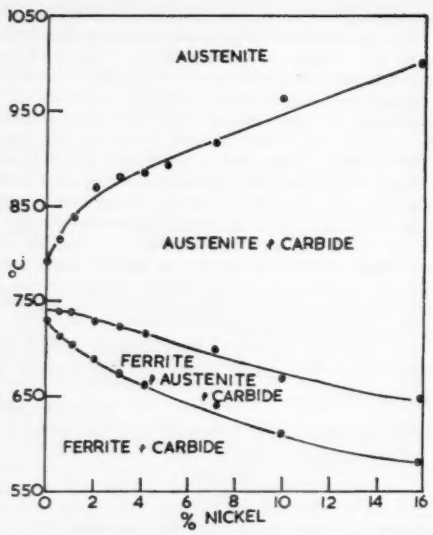

Fig. 1. Phase diagram for iron–carbon–nickel alloys containing 1 per cent carbon and 0·3 per cent manganese; heating-rate 1 deg. C./min.

derived from a ternary diagram based on the assumption of carbide stability. Thus Fig. 1 does not take into account the presence of graphite, which may be found in the higher nickel alloys. The effect of graphitization has been investigated[3] in an attempt to explain an anomalous increase in retained austenite with increasing austenitizing temperatures for certain nickel steels. This abnormality was not observed in similar steels produced by carburization[4], a fact which may possibly be explained by the absence of graphite. As the latter steels were not prepared from the melt or subjected at any time to very high temperatures, the tendency to graphitize may not have been so pronounced.

Graphite was observed in the alloys containing 5 per cent nickel and more, but was not appreciable except in the higher nickel alloys. These alloys also gave increased retained austenite contents on quenching from temperatures above those at which all the carbides were in solution. Estimates of the graphite content of the 15·8 per cent nickel alloy were made after quenching from various temperatures. The results are presented in Table 2 and indicate rapidly increasing solubility of the graphite with increasing temperature of treatment.

It is suggested that there is a graphite solubility line above, and roughly parallel to, the carbide line in alloys containing more than 5 per cent nickel.

Pronounced depression of the austenite–ferrite transformation on cooling is a characteristic feature of these alloys, and the diagram presented is not generally applicable to transformations on cooling.

Table 2. Analysis of Graphite retained on quenching Steel 10 from Different Temperatures

Spec. No.	Oil-quenched from	Microscopic appearance	% Graphite by chemical analysis
A.1	750° C.	Uniformly dispersed fine nodules of graphite	0·46
A.2	920° C.	As *A*.1 but smaller amount	0·18
A.3	1,020° C.	As *A*.1 but very much smaller amount	0·04
A.4	1,100° C.	As *A*.3	0·05

P. Samuel
L. G. Finch
J. R. Rait

Hadfields, Ltd.,
East Hecla Works,
Sheffield 9.
Sept. 13.

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Tidal Forces and the Formation of Hurricanes

Recently, it has been suggested that tidal forces may play a part in the formation of hurricanes[1]. The idea that extra-terrestrial influences may serve in triggering atmospheric phenomena has also received attention from other points of view in recent articles[2,3]. However, it is to be questioned whether the hurricane data presented in Prof. C. H. Smiley's communication offer much support for the tidal hypothesis.

Table 1

Dates and total No. of hurricanes forming in each 7-day period as given in ref. 1	Total No. of hurricanes per 7-day period for the period 1886–1951*		
	East of 70° W.	West of 70° W.	Total
Aug. 24–31 28	25	8	33
Sept. 1–7 27	27	13	40
Sept. 8–14 40	31	17	48
Sept. 15–22 28	17	17	34
Sept. 23–30 17·5	10	15	25
Oct. 1–7 27	18	21	39
Oct. 8–14 26	16	23	39

* These data were assembled by Mr. J. A. Colón, University of Chicago. They cover a somewhat longer period than those cited by Smiley. This accounts for the differences between columns 1 and 4.

The number of hurricanes forming per week has been taken from Smiley's communication and is shown in the first column of Table 1. The increase in the number of hurricanes shortly before September 23 and the decrease after that date are cited as evidence that the frequency of formation is in phase with the magnitude of the tidal forces. However, a somewhat different distribution is obtained if the hurricanes are split into two groups using the 70th meridian as a dividing line. This tabulation, columns 2 and 3 of Table 1, shows that although formations east of 70° decrease substantially after the middle of September, those west of 70° increase even up to the middle of October. Data from other areas can also be cited as evidence that no close relation exists between the frequency of tropical cyclones and the magnitude of the tidal forces. For example, data from the north Pacific[4] show that the maximum frequency of typhoon formation occurs about September 1 and shows an appreciable decrease by September 23.

The large decrease from the number of hurricanes forming in the September 8–14 period to that for the September 23–30 period, which was shown to be statistically significant by Smiley, is quite interesting, however, since it shows up clearly in the divided data of Table 1. Presumably, this apparent singularity

cannot be associated with the tidal forces, since the hurricane frequency increases again after September 30 whereas the tidal force is decreasing. However, it may perhaps be associated with the readjustment of the large-scale flow pattern of the atmosphere which must accompany the westward shift of the preferred area of hurricane formation during late September. Charts of the frequency of hurricane formation prepared by Colón[5] show that during September and October the preferred areas of formation in the Atlantic and in the Caribbean – Gulf of Mexico are separated by a longitudinal strip centred on the 70th meridian in which relatively few storms form. It might therefore be suggested that the low frequency of hurricane formation during the period September 23–30 is associated with a period when the atmospheric circulation in this region is in a transitional stage between the patterns which are favourable for eastern and western developments. From this point of view the singularity, if indeed present, would be the result of significant changes in the atmospheric circulation over the subtropical Atlantic which occur at about the same time each year.

CHARLES L. JORDAN

Department of Meteorology,
University of Chicago,
Chicago 37, Illinois.

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MR. JORDAN'S note suggests that the presence or absence of land has a good deal to do with the formation of hurricanes. I am heartily in agreement with this point of view. Hurricanes are essentially oceanic phenomena occurring generally to the east of land masses.

The fact that South America crowds north into the Caribbean may account for the interesting result Jordan obtains when he divides hurricanes into those born east and west of long. 70° W. The northernmost point of South America is at about this longitude. West of this point the Caribbean approximates to an inland sea; east of it, one has an ocean open to the east. One would not expect to find hurricanes forming in the two areas in exactly the same way, nor would one expect to find atmospheric tides behaving in the same way in both. In this connexion, I would point out that if one divides hurricanes into a large enough number of classes, say, according to longitude at birth, one can certainly obscure any trace of a tidal force acting as a trigger within a given class.

The arguments offered by Jordan do not seem to concern the validity of my reasoning based on the year-by-year count of hurricanes. It would be helpful if a measure of magnitude were available for individual hurricanes; numbers alone do not tell the whole story. Also, there seems to be some question as to whether the available counts of hurricanes and typhoons can be considered reasonably complete. For example, on examining the statistics, one suspects that more hurricanes have been found near steamer lanes or near inhabited islands than in the open ocean. The important activity of weather reconnaissance aeroplanes in recent years may easily have increased the average number of hurricanes discovered in a year.

If it proves to be true that there is a tendency for two or more hurricanes to form at about the same time in areas widely separated in longitude, the tidal-force trigger concept will be strengthened. I do not have at my disposal adequate observational material to carry out this investigation. I hope that someone who has both the necessary data and the required mathematical background will look at this problem. One remembers that 'Edna' 1954 was coming up along the Atlantic coast at the same time that a severe typhoon was moving in toward Okinawa and Japan. Later, when 'Hazel' 1954 was moving northward, another severe storm, perhaps of hurricane strength, was moving northward in the Atlantic Ocean a long way to the east of the United States east coast.

If my estimates of phases and strengths of atmospheric tides are correct, 1955 and 1956 should be good years in which to study this tidal-force trigger concept.

CHARLES H. SMILEY

Ladd Observatory,
Brown University,
Providence 12, R.I.

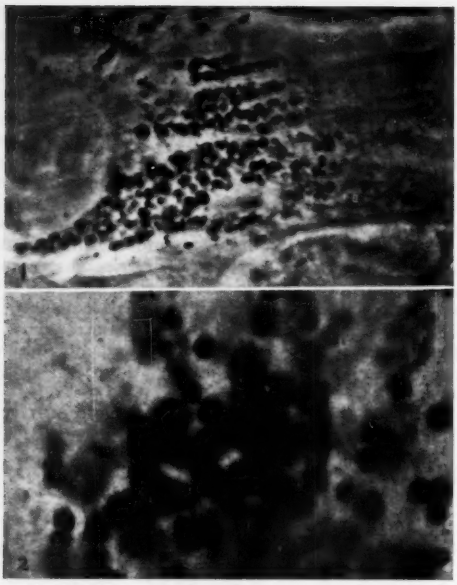
Cytoplasmic Granules in Fibrogenic Cells

A SYSTEMATIC investigation into the method of elaboration of intercellular material in connective and skeletal tissues has shown that cytoplasmic granules, which contain polysaccharide protein components, are present in fibrogenic cells of the fowl embryo both *in vivo* and *in vitro*.

When tissue cultures of frontal bone, tendon or cornea are grown by the hanging-drop technique in a fibrin-free liquid medium and viewed in the living state by phase contrast, cytoplasmic granules of 0·7–2 μ in diameter are very conspicuous in the outgrowing cells. Time-lapse ciné-photography has been used to record their behaviour; the granules are seen to cluster around the nucleus and to be in continual motion in the cell processes, where they are often aligned in rows of several granules (Fig. 1); they move independently of one another and generally along the axis of alignment. Under the oil-immersion lens, the granules show the presence of a less dense centre and in some instances (within the limits of optical resolution) two or more granules appear to join together. They persist throughout mitosis and are still plentiful when some intercellular material has been formed. On application of janus green, the filamentous mitochondria take up the stain, whereas the granules remain colourless. The granules are also stained supravitally by neutral red and gentian violet, which confirms the views of previous investigators[1].

Under the electron microscope, fibroblasts, osteoblasts and osteocytes cultivated directly on electron microscope grids and fixed by osmium tetroxide show granules (Fig. 2) closely similar in appearance to those of the living cell; they are seen to have a diffuse margin and are less dense than the smaller, sharply defined lipid globules that are also present[2]. Thin sections of cultures cut parallel to the surface of the migrating cells show variations of internal density in the granules, whereas the central zone sometimes appears as a separated region. Similarly, in thin sections of tissues from the embryo, the cytoplasmic granules in fibrogenic cells are seen to be non-homogeneous in structure.

It has been found that the granules contain polysaccharide, since after fixation and extraction for



(1) Phase-contrast photomicrograph of part of an osteoblast growing from a living culture of frontal bone, showing the cytoplasmic granules, some of which are aligned in rows. Part of the nucleus can be seen on the left of the photograph. × 1,500

(2) Electron micrograph of part of a similar cell showing the diffuse periphery of the granules and the denser lipid globules. Fixed by osmium tetroxide vapour. × 8,000

lipids and glycogen, they remain intact and can be stained by the use of the periodic acid – Schiff technique. In sectioned tissue the periphery of the granules appears to stain, while the centre remains colourless; the presence of a free aldehyde is excluded as the periodic acid–Schiff method gives a negative response without prior oxidation. The polysaccharide may be acidic in nature, as a positive reaction is obtained by the dialysed iron procedure of Hale[3]; but this method may not be highly specific. On addition of metachromatic stains (toluidine blue, thionine) to living tissue cultures, the granules show the red–purple of metachromasia within three minutes; this may imply the presence of macromolecules with negative charges. It is important to stress that in cultures grown in Tyrode solution alone the outgrowing cells from a tendon explant, for example, still show the presence of metachromatic granules; this would indicate that they have not absorbed metachromatic substances from the normal culture medium in which they are grown. These factors suggest that part at least of the polysaccharide content of the granules is mucopolysaccharide. In this connexion it is of interest that Gersh and Catchpole[4] have recorded barely resolvable intracellular granules in fibroblasts and postulated that they may be of a glycoprotein nature, and Heller-Steinberg[5] has suggested a similar component in frozen-dried preparations of metaphysial bone cells of the rat, and associated their presence with the deposition of new bone.

That the granules contain some protein is suggested first by their ability to take up basic dyes such as eosin, and secondly by ultra-violet microscopy of the living tissues, where there is absorption at 280 mμ while there is no absorption at 313 mμ. In preparations stained by the May Grunwald–Giemsa (Jacobson and Webb[6]) and methyl-green pyronine methods for ribonucleoprotein and deoxyribonucleoprotein, or by the Feulgen technique for deoxyribonucleic acid alone, the granules give no specific staining reaction for either nucleoprotein, nor are the granules destroyed by digestion with ribonuclease or deoxyribonuclease for periods sufficient to remove the known content of ribo- or deoxyribonucleic acid from the cells. On the other hand, in living tissue the granules absorb at 265 mμ; this may be due to spread resulting from the 280 mμ absorption, or may indicate the presence of a nucleoprotein which the staining techniques have failed to demonstrate and the nucleases have failed to remove. However, so far as can be ascertained, both protein and polysaccharide are present in the same granule.

The granules give an alkaline phosphatase reaction by the use of the Gomori–Takamatsu technique, which may well be correlated with the known phosphatase activity of fibrogenic tissue. This suggests that enzyme activities may be localized within the granules, while the existence of other components cannot at this stage be excluded.

As the cytoplasmic granules persist throughout all stages of growth of the tissue, it is reasonable to associate their presence with the elaboration of the intercellular material. It is therefore suggested that the polysaccharide and protein components of the granules may have fibrogenic properties; the granules may secrete, not necessarily continuously, a part or the whole of the ground substance; they may synthesize the collagen fibril itself; or they may contain precursors for the complex extracellular material. The method whereby the polysaccharide and protein components leave the cell is not yet clear, however, for in the living cell no extrusion of intact granules has been observed.

I wish to express my thanks to Prof. J. T. Randall and to Dr. H. B. Fell for their advice and guidance, and to Dr. J. Chayen for the ultra-violet microscopy.

S. Fitton Jackson
Medical Research Council Biophysics Research Unit,
Wheatstone Physics Laboratory,
King's College, London, W.C.2,
and
Strangeways Research Laboratory,
Cambridge. Oct. 5.

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Source of the *Phlei* Growth Factor for *Mycobacterium johnei*

It was first shown by Twort and Ingram[1] that extracts of *Mycobacterium phlei* and certain other acid-fast bacilli contained a growth factor essential for the laboratory cultivation of *Mycobacterium johnei*. They[2] also obtained growth of *M. johnei* on media containing alcoholic extracts of certain food materials of cattle. Since extracts of organs of cattle did not contain this factor and since the principal lesions of Johne's disease are confined to the intestine, they concluded that food was the probable source of the growth factor *in vivo*. Francis *et al.*[3], however, obtained only a very slight stimulation of growth with some extracts of food materials, a stimulation which they considered to be due probably to sub-

stances unrelated to the growth factor; other extracts gave completely negative results. In all this work a form of inspissated egg was used as the basal medium.

Since it was thought possible that either substances present in food might be altered by enzyme or bacterial action in the gut to growth factor, or that the bacteria normally present there might be a source of that substance, it was decided to repeat and extend the observations of these two groups of workers. This study was facilitated by the availability of modifications[4] of Dubos's media suitable for the cultivation of *M. johnei*.

Materials to be examined were first dried in a desiccator and then extracted with ethanol in a manner similar to that used for extracting *M. phlei*[4]. Each extract was added to media in two-fold falling amounts, the highest final concentration in the media being the equivalent of 100 per cent of the dried material before extraction, and the lowest 1·5 per cent. Aqueous extracts of the dried materials were also studied and, in some cases, fresh unheated Seitz-filtered extracts. The basal media employed were the modifications[4] of the liquid and solid media of Dubos and egg media, to none of which had *M. phlei* extract been added. Two strains of *M. johnei* were used as indicator strains. These would not grow at all on media devoid of *phlei* extract. They were lightly inoculated on to media under test, and incubation was carried out at 37° C. for six months. Extracts of the following were examined.

(1) Muscle, liver, pancreas, mesenteric and bronchial lymph nodes, intestinal wall, rumen contents and intestinal contents of ten healthy cows. The diet of five of the cows for some time before slaughter had consisted mainly of fresh grass. The others had been fed on hay, kale and various concentrates.

(2) Rumen contents, intestinal contents and mesenteric lymph nodes of two cows that had died from Johne's disease.

(3) Broth cultures of rumen and intestinal contents of two healthy cows and two that had died of Johne's disease.

(4) Intestinal contents of three sheep, three pigs, three horses and three rabbits.

(5) Five specimens of commercial dried grass meal, five of fresh grass, three of milk and two of oats, wheat, lucerne, clover, kale and hay.

No visible growth of *M. johnei* occurred on media containing any of these extracts.

These results do not support the view of Twort and Ingram that food materials are the probable source of the growth factor *in vivo*. It is more probable that the production of this factor is restricted to acid-fast bacilli and that, as suggested by Francis *et al.*, *M. johnei* does not require a supply of growth factor from an external source when growing *in vivo*, but can synthesize it as adapted strains do *in vitro*. This observation is of significance when the control of Johne's disease is considered.

H. Williams Smith

Animal Health Trust,
Houghton Grange,
Huntingdon. Aug. 25.

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Effect of Vitamin A Deficiency on the Cerebro-spinal Fluid Pressure of the Chick

Animals reared on a diet deficient in vitamin A suffer from a syndrome characterized by the appearance of muscular inco-ordination and weakness, followed by paresis, fits and finally death[1]. This condition occurs in poultry, and has been regarded either as a primary disorder of the central nervous system[2], or alternatively as produced by the compression of a normally growing nervous system by an abnormally growing skeleton[3]. In a preliminary series of experiments, we repeated the work of Wolbach and Hegsted[3], using a diet containing no detectable provitamin A. During the course of these experiments, we found that the cerebro-spinal fluid pressure in the experimental chicks was considerably raised (180–200 mm. of water) as compared with that of a group of control chicks on the same diet with the addition of an adequate supply of vitamin A (90–105 mm. of water).

Further experiments were designed to determine more accurately the relationship between the cerebro-spinal fluid pressure and hypovitaminosis A. Day-old chicks were placed on the following diet: white maize 56 parts, wheat middlings 25, casein 12, dried yeast powder 4, calcium carbonate 1, bone flour 1, salt 1. 180 B.S.I. units of vitamin D_3 was added to each pound of the mash, and the diet was also supplemented with vitamin K and riboflavin. This diet contained 1·6 p.p.m. of carotene. The chicks were weighed twice weekly and showed normal gain of weight. Cerebro-spinal fluid pressure measurements were made on these chicks at various ages and the results are shown in Table 1.

Table 1

Age of chicks in days	No. examined	Mean pressure of cerebro-spinal fluid (mm. water). Standard error in brackets
30	4	108 (16·8)
62	21	157 (7·3)
88	7	180 (12·6)
125	3	212 (19·3)

(Standard errors are based on a pooled estimate of variance within groups.)

Measurements on ten normal chicks of comparable ages confirmed that the average pressure of the cerebro-spinal fluid in the healthy chick is less than 100 mm. of water[4]. Thus the cerebro-spinal fluid pressure in the experimental chicks was raised well above normal values. A statistical analysis of the results showed that there was a constant rate of increase of pressure with age, of estimated amount 1·03 mm. per day with standard error 0·243 (31 degrees of freedom, $P < 0·001$). None of the experimental chicks showed any visible signs of neurological disease at the time when the cerebro-spinal fluid pressure was measured, and at necropsy no bony abnormality was found.

Raised cerebro-spinal fluid pressures in vitamin A deficiency have previously been reported in the calf[5], the sheep[6], and the pig[7]. These findings, together with those reported above, indicate that a raised cerebro-spinal fluid pressure is one of the earliest manifestations of vitamin A deficiency in experimental animals, and that it may make its appearance before any overt sign of neurological disturbance becomes evident.

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Daniels for the statistical analysis, and Miss M. Ellington for technical assistance.

D. H. M. Woollam
J. W. Millen

Department of Anatomy,
University, Cambridge.
Sept. 21.

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Carotenogenesis in *Haematococcus pluvialis*

In a recent communication[1], Goodwin and Jamikorn state that light is necessary for the synthesis of astaxanthin, the carotenoid responsible for the red colour in the alga *Haematococcus pluvialis*. It is not clear whether this conclusion is reached as a result of their own experience or whether they are referring to earlier information[2]. In my opinion the conclusion is erroneous, for the following simple experiment convincingly demonstrates that dark synthesis is possible. The medium consists of 50 mgm./l. soil extract (1 per cent v/v of an extract yielding 5 gm. dry-weight of humic substance per litre on acidification), containing an amount of metabolizable nitrogen equivalent to 5 mgm./l. potassium nitrate, and is enriched with 500 mgm./l. anhydrous sodium acetate. A single green motile cell placed in 6 ml. of this medium multiplied, in complete darkness at 13–18° C. with a relative growth-rate ($\log_2$ increase per day) of 0·55–0·6, to a maximum of $2^{14\cdot3}$ cells per ml. in thirty days, further increase being prevented by nitrogen depletion. At this juncture the cells were still motile and green. Astaxanthin first became visible in the cells on microscopic examination fourteen days later, that is, on the forty-fourth day of the experiment. Encystment was complete after a further ten days, by which time enough astaxanthin had accumulated for the cells to appear bright orange to the naked eye.

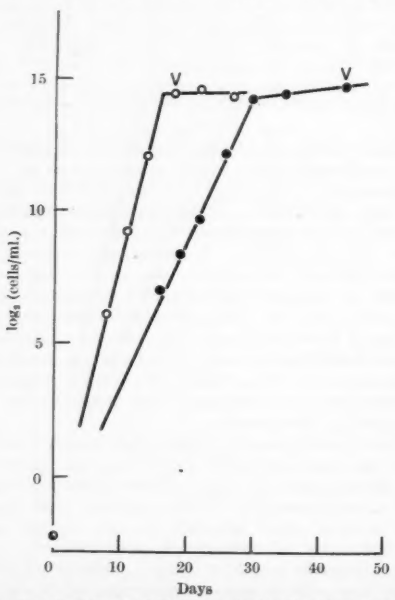

Fig. 1. Growth of *H. pluvialis* from a single cell in the soil extract medium with 500 mgm./l. sodium acetate. Open circles, in the light; closed circles, in the dark. The arrow-heads indicate the first appearance of the carotenoid in the cells on microscopic examination

A comparison of these rates with those obtained in identical media in the light reveals quantitative differences (Fig. 1). In the light, the carotenoid first appears not more than two days after the completion of growth. For clear-cut results, conditions have to be such that exponential increase continues to the point when nitrogen becomes limiting, a condition which is met by the medium quoted. The relative growth-rate in this medium, with a light intensity of 100 ft. candles and with carbon dioxide remaining in equilibrium with the atmosphere, is about double the dark-rate. On the other hand, the rate of astaxanthin synthesis, estimated on the time interval between arrest of growth and first appearance of the carotenoid on microscopic examination, appears to be some seven times greater in the light.

However, a mere difference in magnitude between the ratios of the two rates is insufficient to prove that light is necessary for astaxanthin synthesis, or, indeed, has any action other than indirectly through the photosynthetic apparatus.

It is important to stress that dark synthesis can be overlooked for the reason that, when comparing light- and dark-cultures of the same age, the light-culture is invariably more advanced than the dark and so reaches the point at which the accumulation of the red carotenoid begins (that is, when cell-division ceases) much sooner than the other.

M. R. Droop

Marine Station,
Millport, Scotland.
Sept. 15.

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Saccharides of Different Varieties of Indian Rice

The saccharides of seven rice samples (*Oryza sativa* Linn.), including some old ones that are in common domestic use, have been investigated, with the view of correlating the carbohydrate changes in stored rice with the nutritive value and taste. Four kinds of raw rice (basmati) and three types of parboiled rice (saila) were chosen (basmati and saila are the local names for raw and parboiled rice respectively in northern India). Among the raw rice were included two one-year old samples, one new sample and a fourth that had been stored for three years in tins (30 ± 5° C.). The parboiled rice consisted of the varieties Burdhwan, Mainpuri and Patna.

Circular paper chromatographic technique, as described by Giri and Rao[1], was adopted. The resolution of the saccharides was effected by spotting 50 μl. of the water extract of each sample on the circumference of a circle drawn at the centre of a circular Whatman No. 1 filter paper (33·0 cm. diam.). Along these were also run a mixture of known sugars, including maltotriose and maltotetraose, recently isolated by Whistler and Hickson[2] from corn syrup.

Table 1

Sugars	Known mixture	Raw rice				Parboiled rice		
		Basmati 1 yr. old B_1	Basmati 1 yr. old B_2	Basmati new B_3	Basmati 3 yr. old B_4	Saila 1 yr. old (Burdhwan) S_1	Saila 3 yr. old (Mainpuri) S_2	Saila 1 yr. old (Patna) S_3
Fructose	1·0	1·10	1·11	1·11	1·09	1·09	1·10	1·10
Glucose	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00
Galactose	0·93	0·93	0·92	–	0·90	0·91	0·90	0·91
Sucrose	0·80	0·80	0·79	0·79	0·78	0·79	0·80	0·79
Maltose	0·70	0·69	0·69	–	0·64	0·64	0·64	0·65
*iso*Maltose	–	–	–	–	0·54	–	0·54	–
Raffinose	0·51	0·52	0·52	–	0·50	0·50	0·50	0·51
Maltotriose	0·51	0·52	0·51	–	0·50	0·50	0·50	0·51
Maltotetraose	0·40	–	–	–	0·40	–	0·40	–

After irrigating the chromatogram with *n*-butanol – acetic acid – water[3] (40 : 10 : 50) for 16 hr., the sugars were located by spraying with aniline-diphenylamine phosphate[4]. The separation of various sugars is shown in Fig. 1, and Table 1 represents the corresponding R_G values.

The *iso*maltose bands in B_4 and S_2 were yellowish-brown in colour, similar to glucose, but quite distinct from the blue colour given by maltose, maltotriose and maltotetraose. Raffinose bands were brown, and those containing a mixture of raffinose and maltotriose dirty-blue. The tri- and tetra-saccharide bands were further confirmed by eluting them with water from a separate chromatogram, hydrolysing with 0·5 *N* sulphuric acid and subsequent neutralization with barium carbonate.

Mixed chromatograms were run with the test samples and the known sugars using *n*-butanol – acetone – water (20 : 70 : 10) as the developing solvent.

It is interesting to note that no *iso*maltose, maltotriose and maltotetraose were detected by Williams and Bevenue[5] in American-grown rice samples. This seems to have been due to the fact that their rice samples were not so old, and no enzymatic degradation of starch had taken place.

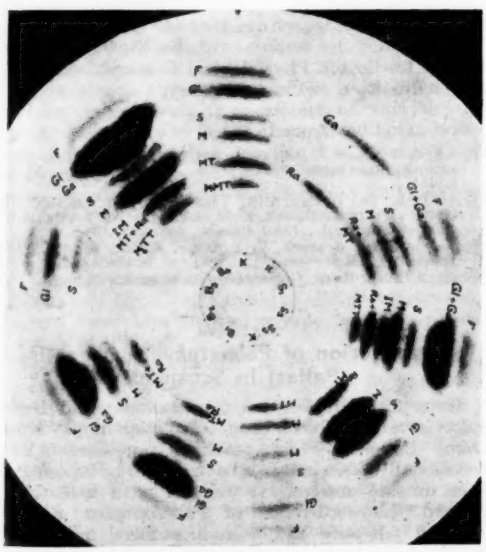

Fig. 1. Circular paper chromatogram showing the separation of saccharides of different rice samples. *K*, known sugars; *F*, fructose; *Gl*, glucose; *Ga*, galactose; *S*, sucrose; *M*, maltose; *IM*, *iso*maltose; *Ra*, raffinose; *MT*, maltotriose; *MTT*, maltotetraose

It has been observed that fructose, glucose, galactose and sucrose are common in almost all varieties of rice. Galactose is not detected in new raw rice. Raffinose is more abundant in parboiled rice (saila). Storage results in the production of a greater proportion of these lower saccharides. The formation of maltose, *iso*maltose, maltotriose and maltotetraose in old samples is possibly due to the action of α-amylase on starch.

These changes in old rice may contribute towards its improved digestibility and better taste, in conformity with the views of Sahasrabuddhe and Kibe[6].

Thanks are due to Dr. R. L. Whistler, of Purdue University, United States, for kindly supplying maltotriose and maltotetraose.

D. B. Parihar

Defence Science Laboratory,
Hillside Road,
New Delhi.
Aug. 9.

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Shikimic Acid in Grass

In a paper describing, *inter alia*, the isolation of quinic acid from grass[1], it was suggested that one of the acids (termed 'acid *B*') present in the grass extracts might be shikimic acid or a closely allied acid. Acid *B* appeared to be identical with 'acid *G*' found by Davies and Hughes[2] in grass and stated by them to be a monobasic acid of relatively high molecular weight. At the time, only a few milligrams of acid *B* was available in solution, and comparison by paper chromatography with authentic shikimic acid showed that the two acids had the same R_F in butanol – formic acid – water, but in benzyl alcohol – *tert*-butanol – *iso*-propanol – formic acid – water and propanol – ammonia – water the mixed acids gave two spots of closely similar R_F value.

Upwards of 100 mgm. of acid *B* has now been obtained from extracts of a pure strain of grass (*Lolium perenne*) dried at 80° C. in a current of air. This specimen had a melting point of 183–184° C. (corrected), mixed melting point with authentic shikimic acid (kindly supplied by Dr. H. O. L. Fischer) 184–184·5° C. (corrected). The elementary analysis gave C, 47·9; H, 5·65 per cent; calculated for shikimic acid, C, 48·3; H, 5·79 per cent. Molecular weight by titration, calculated as a monobasic acid, was 172·6; shikimic acid has a molecular weight of

174·0. $[\alpha]_D^{20}$ for acid *B* was found to be − 179·5° (water, 20 mgm. in 0·5 ml.); Eijkman[3] gives $[\alpha]_D^{18}$ for shikimic acid as − 183·8° (water, *C* = 4·03 per cent).

Acid *B* and shikimic acid gave identical R_F values (alone and mixed) in the three solvent systems mentioned above. It has now been shown that the two spots of closely similar R_F values found previously for acid *B* and shikimic acid were due to contamination of acid *B* with glyceric acid, some, at least, of which was probably formed by the action of the anion exchange resin on the sugars of the original grass extracts during the sepa tion of the acids. We have found that even weakly basic anion exchange resins such as 'Deacidite G' react in the 'OH' form with sugars to give several acids, including glyceric acid, which has an R_F value similar to shikimic acid in the three solvent systems used. In the present work this difficulty was overcome by using 'Deacidite G' in the acetate form for the separation of the acids from the sugars in the grass extracts freed from amino-acid.

It is now beyond doubt, therefore, that acid *B* of grass is shikimic acid. Work is proceeding on the isolation of the other unidentified acids in the grass extracts, and the results will be reported in detail elsewhere.

A. Richardson

Edward Davies Chemical Laboratories,
University College of Wales,
Aberystwyth.

A. C. Hulme

Ditton Laboratory,
Food Investigation Organization
(Department of Scientific
and Industrial Research),
East Malling, Maidstone, Kent.
Sept. 16.

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Effect of α-Naphthalene Acetic Acid on Yield of Indian Cotton

Reduction in boll shedding was noticed when injuries to the cotton plant were reported as a result of spraying with 2,4,dichlorophenoxy acetic acid[1]. Depletion of non-reducing sugars and accumulation of proteins and amino-acids are common effects of several synthetic hormones[2]. Applications of α-naphthalene acetic acid and certain other growth regulators have been found to effect an increase in the setting percentage of bolls and yield of seed cotton[3]. The effects of the applications of these hormones on photosynthetic activity and fruiting with enhanced carbohydrate–nitrogen metabolism in the cotton plant have been recently studied[4].

Most of these observations were made on American or other exotic varieties of cotton. A preliminary investigation on the effects of α-naphthalene acetic acid on the carbohydrate changes in the leaves and yield of seed cotton of Dhar 43 (an improved strain of Bhoj, *Gossipium arboreium*) was undertaken during the 1953–54 cotton season. An attempt was made to find whether the application of α-naphthalene acetic acid as a spray on desi (Indian) cotton plants would prove beneficial at the active stage of vegetative growth or at the onset of the reproductive phase. The hormone was applied in three doses, of 10, 20 and 30 parts per million.

Table 1

Treatment	Yield of seed cotton (lb. per acre)	Increase over control	Increase (per cent)
Control	466·2	—	—
Early spray at the active stage of vegetative growth :			
10 p.p.m.	567·0	101·4	21·75
20 p.p.m.	537·6	71·4	15·31
30 p.p.m.	516·6	50·4	10·81
Late spray at the commencement of reproductive phase :			
10 p.p.m.	582·6	116·4	24·96
20 p.p.m.	593·2	127·0	27·24
30 p.p.m.	569·1	102·9	22·07

Standard error of response over control, 45·8; significant difference, 97·5.

Carbohydrate–nitrogen status in the leaves of the plants receiving late spray was higher at certain stages of growth than all other early spray treatments and the control. Also, there appears to be more effective carbohydrate utilization by plants receiving late spray, because of their comparatively higher yield of seed cotton than any other early spray treatments.

Early spray of 10 p.p.m. of α-naphthalene acetic acid and all the three late-spray treatments showed statistically significant increase in the yield of seed cotton over the control. Percentage increases in yield were more in late-spray treatments than in early-spray treatments.

These observations are being extended for confirmation and will be published in detail elsewhere.

We are grateful to Prof. R. H. Dastur, plant physiologist for the Scheme for Cotton Physiological Research, Indian Central Cotton Committee, for guidance; the financial support of the Committee for this investigation is also acknowledged.

Jayendra Bhatt
R. V. Date

Scheme for Cotton Physiological Research,
Institute of Plant Industry,
Indore.
Aug. 16.

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Distribution of *Pelmatohydra oligactis* (Pallas) in Scotland

Since 1918, *Hydra vulgaris attenuata* and *Hydra vulgaris vulgaris* have been cultivated in the Notre Dame Laboratory for teaching purposes. Very occasionally these cultures have had to be replenished from outside sources. It was not until 1946 that I noticed the occurrence of *Pelmatohydra oligactis*, which I felt sure had been introduced in material obtained from a dealer in the south of England. The *Hydra vulgaris vulgaris* were completely ousted by the rapid spread of *Pelmatohydra oligactis*. In October 1947 all the specimens were reproducing

luxuriantly; even small individuals were covered with testes. After this efflorescence, the organisms gave place to *Hydra vulgaris vulgaris*.

Although our collecting was by no means exhaustive, and was not primarily for hydra, yet we never recorded *Pelmatohydra oligactis* in our catches. Indeed, I had concluded from laboratory observations that this species required a warmer temperature than that of the Glasgow area. It was a great surprise, therefore, to be shown by Mr. A. MacKinnon (of the Zoology Department, University of Glasgow) a catch of *Pelmatohydra oligactis* obtained by his collectors from water-weeds of a Milngavie pond. The circumstantial evidence points to the fact that the species has spread to Scotland. Unfortunately, records of the occurrence of *Hydra* in Scotland are not easily obtainable. I should be grateful for information of the existence of *Pelmatohydra oligactis* in Scotland before 1940.

MONICA TAYLOR

Notre Dame College,
Glasgow.
Sept. 29.

Enhanced Light Absorption by Compounds in Chromatograms

WE have investigated some characteristics of a hyperchromic absorption of light that takes place when a compound in dry chromatographic paper is transilluminated with radiation of absorbable wavelength. Laurence[1] has previously noticed and interpreted such enhanced absorption, but no results were presented, and the phenomenon has escaped general recognition. It is a true[2] absorption, and not a manifestation of varying spatial distribution of the transmitted light. All evidence indicates that it is caused by transit of photons through dry paper via paths longer than rectilinear lines directly through the paper and the layer of absorbing compound therein. Multiple refractions augment the effective optical depth in the manner described by Keilin and Hartree in photometric studies of compounds in devitrified frozen solvents[3].

To evaluate true absorption of ultra-violet light without interference from effects of variable geometrical distribution of the transmitted light, several techniques were applied and found to yield the same results. A fluoroscopic photometer[4] was applied in some instances because it intercepts and responds uniformly to the total light transmitted by a papergram. For application of other detecting systems, dry Whatman No. 50 paper sealed in polyethylene was used to scatter randomly the incident light or transmitted light, or both; the diffuse transmission pattern resembles that of visible light on passage through opal glass[5].

That the hyperchromic absorption is dependent upon light refraction was established by saturating papergrams with oil ('Nujol') and other liquids of refractive index approaching that of cellulose, *c.* 1·5. The absorption of 254 mμ light was diminished by a factor close to one-third (Figs. 1 and 2), and was restored on removal of impregnating fluid by evaporation or by washing with an appropriate volatile solvent. Restoration of hyperchromic absorption during evaporation of a volatile liquid was followed kinetically and found to occur simultaneously for several deposited compounds and for absorbing constituents of the paper itself. Time curves for

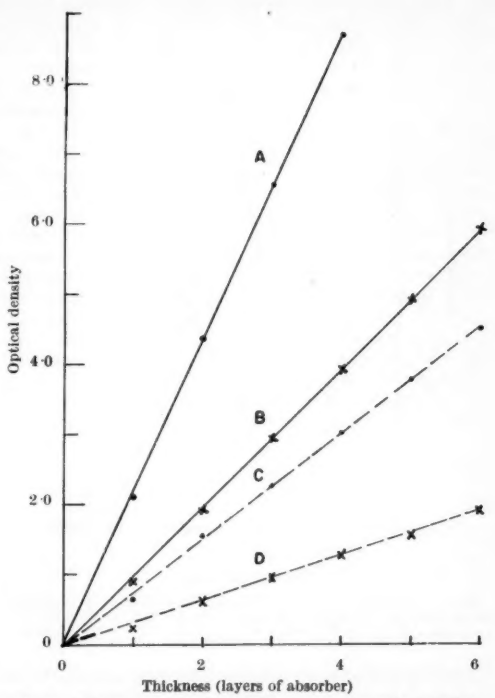

Fig. 1. Absorption of light of 254 mμ as a function of thickness of absorber. (*A*) Adenylic acid layer 16 millimicromoles per sq. cm. thick in dry Whatman No. 11 paper; (*B*) dry Whatman No. 11 paper; (*C*) adenylic acid of same thickness in oiled paper; (*D*) oiled paper

increased absorption parallel those for increased scattering of collimated light away from the line of incidence.

Typical findings for absorption of light of 254 mμ are shown in Fig. 1, where density was measured with an extremely sensitive photon counter designed for chromatographic densitometry[4]. With I_0 at 5,000 photons per sec. without absorber, the absorbing layers were inserted between a source of diffuse monochromatic light and the detector. Whenever the intensity of light transmitted to the detector decreased to less than 50 photons per sec., the initial photon flux was restored by adjusting intensity of incident light, and the measured density of 2·0–3·0 was added to subsequent values. Absorption by constituents normally present in chromatographic papers and by deposits[4] of adenylic acid is seen to follow the Lambert–Beer law:

$$\text{Optical density} = E = \log_{10} I_0/I = kt. \quad (1)$$

For absorption per layer of absorber, t represents the number of thicknesses or sheets. To consider absorption of deposited compounds on a molar extinction basis, the thickness is conveniently expressed in dimensions of mass and area[6,7], thus:

$$\text{Thickness } (M/1{,}000 \text{ cm.}^2) = \text{length (cm.)} \times \text{concentration } (M/1{,}000 \text{ cm.}^3). \quad (2)$$

If dry chromatographic paper is used, the constant, k, may be regarded as a molecular extinction coefficient, ε_s, for a compound in a diffusely scattering matrix. While the value of this coefficient is dependent upon properties of the standard matrix used and diminishes in magnitude as the thickness of

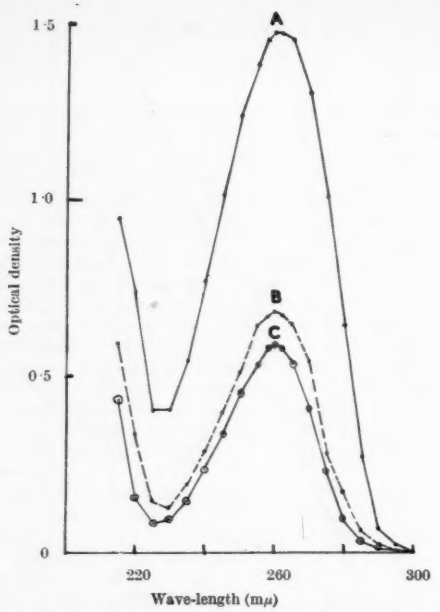

Fig. 2. Spectral absorption curves of adenylic acid in paper and solution. Thickness of nucleotide, 40 millimicromoles per sq. cm. (*A*) In dry Whatman No. 50 paper; (*B*) in oiled Whatman No. 50 paper; (*C*) in neutral aqueous solution

deposit per sheet of paper increases, studies to be presented in a detailed report show a simple relationship to the conventional molar absorption coefficient.

E_{254} for a single sheet of dry Whatman No. 11 paper is shown to be 1·0 in Fig. 1. Corresponding values for Whatman papers No. 1, 50, 3*MM* and 3 are 1·3, 1·3, 2·0 and 2·4 respectively. For a 16 millimicromole per sq. cm. layer of adenylic acid in neutral Whatman No. 11 paper, Fig. 1 shows that E_{254} is 1·19, and the ε_{254} is calculated to be 74,000. This exceeds by a factor of 5·2 the value of ε_{254} for adenylic acid in neutral aqueous solution[8].

Conformity of the density to thickness relationships of Fig. 1 with the Lambert–Beer law contrasts sharply with results of studies[4,9] wherein multiple thicknesses of absorber were evaluated in single sheets of chromatographic paper. Departure from linearity under the latter condition occurs with use of monochromatic light, and is adequately explained on two bases: the fractional diminution of optical density due to the presence of relative holes and valleys in a single sheet of paper becomes greater as the average density increases, an effect which is small with papers that are thick, uniform and dry; a second and fundamentally important basis is inherent to the three-dimensional absorption inevitable in a diffusely scattering matrix. A linear increase of density with thickness (Equat. 1) is theoretically tenable only if each increment of absorber exerts no influence on the fraction of incident photons absorbed by the other layers. Such an influence is exerted when successive layers of absorber are added to a single diffusely scattering matrix, that is, a single sheet of chromatographic paper. At small thicknesses (Equat. 2) of absorber, the average path-length of transmitted photons must be nearly three times the linear distance through the paper due to equal excursions into the two dimensions of the plane of the paper. Multiple reflexions from surfaces and total reflexions inside fibres of the paper may further augment the path-length. By preferential removal of those photons which are scattered over the paths of greater length, each increment of absorber must shorten the average photon path through all subsequent increments. To an ever-increasing extent, the transmitted photons will be members of the small fraction which, in the process of diffuse scattering, happens to be directed along the shortest paths through the paper. Hence, the ΔE due to each Δt will become smaller as E increases.

While the foregoing considerations preclude rigorous linearity of density to thickness plots for compounds in the form of deposits in a single sheet of paper, empirical relationships can be established with high precision. Reported methods for securing rectified plots[9,10] are of some value, but fail when applied over wide ranges of absorber thickness.

Absorption by adenylic acid as a function of wave-length (Fig. 2) was estimated with conventional techniques. Removal of collimated incident light by the nucleotide was determined by comparison with a blank using the Beckman spectrophotometer with the 4,300 photomultiplier attachment. Investigation of other compounds shows that hyperchromic absorption occurs throughout the ultra-violet and visible spectra.

Full implications of hyperchromic absorption in chromatographic densitometry remain for future appraisal. It is quite constant under standardized conditions, and appears to be a useful property if recognized.

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T. D. Price
P. B. Hudson
D. F. Ashman

Departments of Biochemistry and Urology,
and the Institute of Cancer Research,
Columbia University College
of Physicians and Surgeons,
and Francis Delafield Hospital,
New York 32, N.Y.

Aug. 23.

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Adsorption of Glucose on a Weakly Basic Anion-Exchange Resin

Although furfural[1] is adsorbed on the weakly basic anion-exchange resin 'Amberlite *IR*-4*B*', the adsorption of sugars has not been reported; in fact, this resin has been used to de-ionize solutions prior to the estimation of sugars[2]. However, following the detection of traces of sugars in the acid fraction from fruit extracts, it has now been found that as much as 1 per cent of the glucose passed through a column of 'Amberlite *IR*-4*B*' may be adsorbed on the resin.

In studying the adsorption of sugars, two synthetic mixtures of sugars and acids were passed through small columns (5 gm. air-dry resin) of 'Amberlite *IR-4B*'. One column had been used many times to collect acids from fruits, the other was freshly packed from a different batch of resin. The mixtures of sugars (glucose, fructose and sucrose) and acids (malic, citric, quinic, galacturonic and phosphoric[2]) were similar in composition to those obtained after removing the cations from extracts of pears and peaches. The aliquot used for each experiment contained two or four milli-equivalents of mixed acids and 3 gm. of sugars including 0·4 or 2·6 gm. of sucrose. Following the passage of the sugars and acids, the column was washed with water. The first 100 ml. was discarded. The rest of the washings was collected in fractions some of which were concentrated (usually 100 : 1) under reduced pressure for paper chromatography.

All the fractions run on paper gave a good glucose spot, even after the column had been washed with two litres of water. In the case of the mixture with the high sucrose concentration, early fractions gave a good sucrose spot, otherwise only traces of sucrose and fructose were detected. All fractions contained quinic or galacturonic acid, or both, depending on their relative proportions in the mixture; the other (stronger) acids were not detected. Similar results were obtained with both columns, with rates of washing varying from 0·25 to 2 ml. per minute, and after regeneration of the resin with 2 *N* ammonia or 2 *N* sodium carbonate.

Some quantitative work was done using solutions of glucose. Aliquots were run through the columns, followed by 200 ml. of water and then by 50 ml. 2 *N* ammonia or 50 ml. 2 *N* hydrochloric acid. The water wash recovered 98–100 per cent of the glucose used, the ammonia a further 0·01–0·1 per cent, the acid a further 0·3 per cent. Successive washings with 2 *N* hydrochloric acid, allowing the acid to stand on the column, eluted altogether 0·7–1·0 per cent of the glucose used. The glucose was estimated by reaction with anthrone[4], using a solution of glucose in 2 *N* hydrochloric acid as a standard in appropriate cases. It was necessary to wash the new column thoroughly with 2 *N* hydrochloric acid to obtain a satisfactory blank.

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T. M. Reynolds

Division of Food Preservation and Transport,
Commonwealth Scientific and
Industrial Research Organization,
Homebush, N.S.W.
June 17.

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Energy of Activation for the Acid-catalysed Hydrolysis of Esters

Activation energies of the order of 30 kcal./mol. have been found for the acid-catalysed hydrolysis of *tert.*-butyl 2 : 4 : 6 trimethylbenzoate and *tert.*-butyl benzoate, for which the reaction has been shown to proceed by alkyl–oxygen fission[1], and of *tert.*-amyl 2 : 4 : 6 trimethylbenzoate, *tert.*-amyl benzoate, diphenylmethyl 2 : 4 : 6-trimethylbenzoate and α-methylallyl 2 : 4 : 6-trimethylbenzoate, where the same mode of fission may be predicted. This value is significantly higher than that found for the hydrolysis of esters by acyl–oxygen fission, and seems to be characteristic of this mechanism.

The rate of hydrolysis with acyl–oxygen fission increases markedly from benzoates to acetates, and the transition in mechanism would be expected to occur in the region of *tert.*-butyl acetate. This appears to be the case, for the Arrhenius equation is not followed in the hydrolysis of *tert.*-butyl acetate, the activation energy varying from 26 to 30 kcal./mol. between 50° and 100°, which implies, however, predominantly alkyl–oxygen fission, in agreement with the results of Bunton, Comyns and Wood[2]. Preliminary experiments on *tert.*-butyl formate give an activation energy of *c.* 16 kcal./mol., which is normal for the acyl–oxygen fission of esters of aliphatic acids. This is consistent with the behaviour of diphenylmethyl formate mentioned by Day and Ingold[3].

V. R. Stimson

New England University,
Armidale,
New South Wales.
Sept. 19.

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A General Method of Aminomethylation

Einhorn discovered that methylolamides condense with phenol (in concentrated sulphuric acid), in accordance with the equation:

$$C_6H_5OH + RCONHCH_2OH \rightarrow C_6H_4(OH)CH_2NHCOR + H_2O.$$
(R = aryl or alkyl).

It has now been shown that the above reaction is a general one which can be used to introduce CH_2NH_2 groups into many aromatic compounds. Thus benzene can be condensed, according to the conditions of the experiment, with one or two molecules of the methylolamide giving $C_6H_5CH_2NHCOR$ or $C_6H_4(CH_2NHCOR)_2$. These compounds are readily hydrolysed, with alcoholic hydrochloric acid, to the hydrochlorides $C_6H_5CH_2NH_2HCl$ and p-$C_6H_4(CH_2NH_2)_2 2HCl$ (and another isomer). Some methylated benzenes (toluene, the xylenes and mesitylene) have also been condensed. In each case three CH_2NHCOR groups can be introduced into the molecule.

Naphthalene also reacts, but the products obtained are difficultly soluble and have not yet been separated.

The reaction was successful with the following mono-substituted benzenes: chloro-, bromo-, iodo-, cyano-, sulphamido-. In each case only one CH_2NHCOR group was introduced. Nitrobenzene, benzamide and acetophenone did not react. From thiophene the compounds $C_4H_3S.CH_2NHCOR$-2 and $C_4H_2S(CH_2NHCOR)_2$ were prepared.

Details of these experiments will be published elsewhere.

R. Ó. Cinnéide

Department of Chemistry,
University College,
Cork.
Sept. 8.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 3

British Psychological Society, Education Section (in collaboration with the Conference of Educational Associations, at University College, Gower Street, London, W.C.1), at 2.30 p.m.—Dr. Robert Logan: "Healthy Youth of To-day—In the Absence of Major Disease What are the Health Needs of Youth?"

British Museum (Natural History) (in the Huxley Lecture Theatre, Imperial College of Science and Technology, Exhibition Road, South Kensington, London, S.W.7), at 5.30 p.m.—First of a series of twelve lectures on "The Geology and Scenery of South Africa" by Prof. Frederick Walker (University of Cape Town). (Swiney Lectures on Geology.) Further lectures on Mondays, Wednesdays and Fridays until January 28.*

Tuesday, January 4

Institution of Electrical Engineers, Measurements and Radio Sections (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. H. McGregor Ross: "Equipment of Instrumental Accuracy for Recording and Reproduction of Electrical Signals using Cinematographic Film".

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. C. H. E. Warren: "Recent Advances in the Knowledge of Transonic Air Flow".

Tuesday, January 4—Friday, January 7

Geographical Association (at the London School of Economics, Houghton Street, Aldwych, London, W.C.2)—Annual Conference.

Wednesday, January 5

British Psychological Society, Industrial Section (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr. Robert Sergean: "Communication of Information within Management Groups".

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. N. T. J. Bailey: "Some Problems in the Statistical Analysis of Epidemic Data".

Thursday, January 6

Royal Aeronautical Society (at the Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1), at 3 p.m.—Mr. P. G. Masefield: "Great Events in Aviation" (Lecture to Young People).

Royal Geographical Society (joint meeting with the Geographical Association, at 1 Kensington Gore, London, S.W.7), at 3 p.m.—Mr. F. Spencer Chapman: "African Journey".

Royal Society of Arts, Commonwealth Section (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. R. L. Prain: "The Copperbelt of Northern Rhodesia" (Henry Morley Lecture).

Institute of Metals, London Local Section (at 4 Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Prof. A. H. Cottrell: "Some Aspects of Twinning and Kinking in Metals".

Friday, January 7

Institute of Physics, Industrial Spectroscopy Group (at 47 Belgrave Square, London, S.W.1), at 4.30 p.m.—Dr. R. E. Richards: "The Chemical Applications of Nuclear Resonance Spectroscopy"; Dr. J. Sheridan: "Microwave Spectroscopy".

Saturday, January 8

E.E.G. Society (at the National Hospital, Queen Square, London, W.C.1), at 10.30 a.m.—Scientific Papers.

British Mycological Society (in the Physics Lecture Theatre, Birkbeck College, Malet Street, London, W.C.1), at 11 a.m.—Scientific Papers.

British Interplanetary Society (in the York Hall of Caxton Hall, Caxton Street, Westminster, London, S.W.1), at 6 p.m.—Mr. A. V. Cleaver: "Using Hydrogen Peroxide"; Mr. S. Allen: "Liquid Oxygen as a Rocket Propellant".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Engineer (with a good honours degree in mechanical engineering or equivalent professional qualifications, and preferably some experience in research), at the Central Research Establishment, National Coal Board, Isleworth, Middlesex, to carry out research on coal cutting—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/894 (January 6).

Scientific Assistant (graduate in science or agriculture, and preferably with special training in nutrition and/or a knowledge of foreign languages), for duties which will include abstracting, indexing and proof reading—The Director, Commonwealth Bureau of Animal Nutrition, Rowett Research Institute, Bucksburn, Aberdeenshire (January 8).

Scientist, Grade III (with an honours degree in mathematics, and preferably a qualification in statistics) on the Headquarters staff of the Pneumoconiosis Field Research (Environmental Survey) in London, for duties which will involve the analysis and correlation of statistical data collected by field investigators in the coalfields—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/895 (January 10).

Assistant Experimental Officer in the Genetics Department, to be responsible for the maintenance of genetic stocks, and to assist the Head of the Department—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (January 15).

Assistant (female) (preferably with a degree in biology or horticulture, or equivalent qualifications), for field experiments on fruit crops carried out by the Plant Pathology, Entomology and Plant Protective Chemistry Sections—The Secretary, East Malling Research Station, near Maidstone, Kent (January 15).

Mathematician (with H.S.C. (science) or equivalent) at the Ministry of Supply Radar Research Establishment, Malvern, Worcs, to supervise operators using auxiliary punched card machines for scientific calculations and to conduct intricate card handling processes on a high-speed punched card computer—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.362/54A (January 15).

Demonstrator in the Department of Bacteriology—The Registrar, The University, Leeds 2 (January 31).

Senior Lecturer in Physiology, and a Lecturer in Physiological Chemistry, at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, January 31).

Lecturer (graduate in science or agricultural science) in Botany at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, February 1).

H. Jones and Co. Pineapple Research Fellow (graduate, preferably with an interest in the fields of plant pathology and/or plant physiology) to investigate problems relating to pineapple production in South Africa—The Registrar, Rhodes University, Grahamstown, South Africa (February 28).

Professor of Chemical Engineering in the University of Manchester and in the College of Technology—The Registrar, College of Technology, Manchester 1 (February 28).

Assistant (graduate in organic chemistry) in the Cancer Research Department—The Secretary and House Governor, Mount Vernon Hospital, Northwood, Middlesex.

Biochemist (basic grade) (with an appropriate science degree or the A.R.I.C., or an equivalent qualification) in the Group Laboratory—The Secretary, Royal Hospital, Chesterfield.

Experimental Officer or Assistant Experimental Officer (with at least H.S.C. in science subjects or Higher National Certificate in physics, or equivalent qualifications), to work in a section dealing with irradiation damage which will involve experimental work in connexion with research on the metal physics of existing and proposed fuels for nuclear reactors—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/210.

Forestal Land, Timber and Railways Co., Ltd., Research Fellow (with at least a good honours degree in chemistry and preferably some research experience, and particular interest in applying fundamental physical chemistry and physical methods of organic chemistry to problems of industrial importance), at the Chemical Research Laboratory of the Department of Scientific and Industrial Research, Teddington, for research which will be directed to investigating the function of tannins in preventing corrosion of metals—Chief Research Chemist, Forestal Central Laboratory, Harpenden, Herts.

Graduate in Physics for experimental work in solid state physics, particularly semi-conductors—The Personnel Officer, Research Laboratory, Associated Electrical Industries, Ltd., Aldermaston Court, Aldermaston, Berks.

Laboratory Technician (with experience in a chemical or physical research laboratory, and preferably with some knowledge of vacuum technique), for work in the radioactive isotope laboratory—The Secretary, Barnato Joel Laboratories, Middlesex Hospital, London, W.1.

Lecturer (graduate in chemistry or biochemistry and experience in the food industry, preferably in the technology of edible oils and fats or of cereals)—The Registrar, National College of Food Technology, Cranwood Street, City Road, London, E.C.1.

Senior Scientific Officer or Scientific Officer (with a first- or second-class honours degree in physics), and Experimental Officers or Assistant Experimental Officers (with at least H.S.C. (science) or equivalent qualifications), for the development and operation of a mass spectrometer with emphasis on the analysis of solid materials—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/208.

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